THE SECTORS' PARADIGM

a study of the spatial and functional nature of modernist housing in Northeast Brazil

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ABSTRACT

Research on domestic architecture using the space syntax method has suggested that while most vernacular traditions are characterised by 'genotypical' consistencies in the relation between spatial configuration and functional 'ends', such consistencies are usually lacking in experimental modernist architecture, where instead a consistency in spatial composition gives rise to 'genotype of means' rather than to 'genotypes of ends'.

In Brazil, however, modernist housing became a established tradition and therefore there may be in them spatio-functional consistencies as found in vernacular tradition. The thesis examines how far this is the case, based on the fact that the dominant idea about the spatial organisation of the modernist dwelling was that it should be organised into spatially distinct 'sectors', within which similar activities could be clustered. This concept provided a pervasive underlying diagram, or paradigm, for housing organisation. No studies have been done however of how this paradigm worked out in practice. This thesis investigates this question with respect to a manifestation of this idea in the modernist architecture of Recife, between 1930 and 1980.

The thesis first diagnoses the existence of a 'sectors' paradigm' in a pilot sample of modernist houses, then extends the investigation to a larger sample to see how prevalent it is and what different spatial forms it takes. The thesis then looks at historical houses and shows that a sectors' model can also be detected in them, but quite different spatially and functionally. It shows that both the internal form of the sectors and the way they are linked together are the key determinant for differentiating domestic activities and household members in both historical and modern dwellings.

The thesis concludes that, through the methodological innovation of sectors' analysis, spatio-functional 'genotypes of ends' can be shown to be present in Recife's modernist dwellings, but that also they can be detected in vernacular houses, suggesting that a first layer should be added to the syntactic analysis of vernacular buildings.

To Sérgio do Eirado Amorim

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INTRODUCTION

1.2.2. The age of method

A more accurate and precise idea of sectors in domestic space is seen in the treatise on the 'principles which regulate the plan of an English residence at the present day' (Kerr, 1864: 1), written by Robert Kerr, who was a Professor of the arts of construction in King's College, London. Kerr considers the need for privacy in domestic architecture the fundamental problem in designing the English gentlemen's house. A substantial introductory part of his book is dedicated to a historical review on the spatial and functional arrangement of the English house, particularly concerning the degree of privacy existent in the domestic environment. He traces the introduction of individual functional rooms into the household. The Saxons' Common Hall, where all domestic activities were held, evolved with the isolation of the kitchen and the household head's accomodation, but only the more recent multiplication of bedrooms, corridors and passages assured the necessary domestic privacy (Kerr, 1864: pp 30-44).

According to Kerr, the gentlemen's house ought to be 'divisible into two departments, namely that of THE FAMILY, and that of the SERVANTS' (Kerr, 1864: 70). This is because the family and the servants constitute different communities and 'each class is entitled to shut its door upon the other, and be alone' (Kerr, 1864: 76). Furthermore, providing privacy to the servants gives 'that freedom from interruption which is essential to the efficient performance of their work' (Kerr, 1864: 221). This departmentalisation ought to be observed in all houses, regardless of social class. However, 'as the importance of the family increases the distinction is widened - each department becoming more and more amplified and elaborated in a direction contrary to the other' (Kerr, 1864: 70). Kerr details each department regarding to the number and types of rooms:

The FAMILY DEPARTMENT may be subdivided thus: The Day-rooms; the sleeping-rooms, the Children's -rooms, the Supplementaries, the Thoroughfares. (...) The SERVANTS' DEPARTMENT may be subdivided in this manner: The Kitchen Offices; The Upper Servants' Offices; The Lower Servants' Offices; The Laundry Offices; The Bakery and Brewery Offices.; The Cellars, Storage and Outhouses; The Servants' private rooms; The Supplementaries, the Thoroughfares (Kerr, 1864: 71).

Furthermore, Kerr specifies the need to avoid unexpected co-presence of inhabitants, visitors and servants, because 'whether in a small house or a large one, let the family have free passage without encountering the servants unexpectedly', as well as 'let the servants have access to all their duties without coming unexpectedly upon the family or visitors' (Kerr, 1864: 75). The author proposes the use of independent corridors and staircases to differentiate inhabitants, visitors and servants circulations (Kerr, 1864: pp 195-199).

The horror of mixing servants and family, and the need to segregate women in the residences echo, according to Evans (1997), Alberti's demands for domestic privacy. Architecture, however, was used by the architects in a rather different manner. For Alberti, providing privacy was 'a matter of arranging proximity within the matrix of rooms'; whereas for Kerr, his demands were solved by 'bringing to bear a range of tactics involving the meticulous planning and furnishing of each part of the building under a general strategy of compartmentalisation on the one hand, coupled with universal accessibility on the other' (Evans, 1997: 78).

Kerr describes his own design method of attending these requirements and simultaneously achieving a compact arrangement in order to simplify communication in the house. His method consists of defining a complete classified list of rooms, with their dimensions and requirements, and representing them on small pieces of paper, which then can be attached to the transitional spaces (Kerr, 1864: pp 84-85). If not theoretically elaborated, Kerr's method and proposed typology for the Victorian English house are similar to the modern design procedures and social organisation of a dwelling. However, the emphasis on the method and a more refined concept of domestic organisation is to be seen in the work of Viollet-le-Duc, the pioneering theorist of modern architecture (Heath, 1984; Johnson, 1994; Hearn, 1995)

Viollet-le-Duc's ideas anticipated the modern debate on design methods and rational construction. He considered that buildings should be conceived on the basis of a rational method of design, rather than on the composition of existing historical models. This method should be based on the elaboration and interpretation of a functional program. These functional requirements would give order and shape to the plan, as well as to the architectural composition and building's structure. To Viollet-le-Duc, asymmetric composition should not be avoided, as prescribed by academics, if functionally required. This logical system of principles, which prioritises function over form, also stated by Sullivan's 'form follows function' (Sullivan, 1896), is exemplified in Viollet-le-Duc's ideal house.

The problem of the ideal house is presented by Viollet-le-Duc as a reflection on the recent changes in French society. According to him, in the aristocratic society the deep inequalities which formed class distinction and status inertia, permitted an accessible and open domestic environment. In the aristocratic society 'life was lived in common without inconvenience, because there was no reason to fear that subordinates would ever forget the social distances that separated them from their superiors' (Hearn, 1995: 263). By contrast, in democratic societies class barriers may be overcome, therefore, there is the need to entrench the 'master of the house' from the intrusion of strangers and servants. He summarises:

We conclude (...) that domestic architecture in an aristocratic state of society may affect a breadth and simplicity in its arrangements that would be intolerable in a democratic condition, where each department in the dwelling must be distinct and definite, in proportion to the equality before the law that exists between masters and servants (Hearn, 1995: 263).

Based on these arguments, the ideal house expresses in space the separation between inhabitants and servants, and reinforces the privacy of the family against visitors, because 'we receive a good many people with whom we have but the slightest acquaintance' (Hearn, 1995: 255). For this reason, the reception rooms should be on the ground floor, and the family accommodations on the first floor. Furthermore, isolating circulation systems for inhabitants, visitors and servants is one of the key functional aspects of the house, preserving each zone from the intervention of the others.

The rationalist methods conceived by Viollet-le-Duc would pervade most of the architectural thought of the XX century, reaching its peak with the uprising of the 'design methods movement' in the 1960s. Particularly, his solution for the ideal house in a democratic society became the prototype of the modern zoned house (Hearn, 1995: 253), reinterpreted by some of the most expressive modern architects, such as Frank Lloyd Wright. In fact, Wright was an enthusiastic reader of Viollet-le-Duc's writings (Hearn, 1995: 14). Not surprisingly, in an article entitled *The Two-Zone House - suited to country, suburb and town* (Wright, 1993), Wright proposed the prototypical functional arrangement of the North American house, which should have 'two centers, a center of activity and a center of quiet, and should be designed accordingly' (Wright, 1993: 172).

Wright's 'two-zone house' excludes the servants from the household. In his idealised modern society, outside help would be more professional and come to the house only when required. In the meantime, the revolutionary domestic appliances, or the 'modern labour saving devices' (Wright, 1993: 174), would ease housewife's daily routine.[3] Therefore, Wright's domestic zones are not conceived to reinforce social inequalities, but to secure adequate private and communal areas in the house.

1.2.3. On design methods

An evolution of Wright's concept is seen in the work of Marcel Breuer. His 'bi-nuclear' house is characterised by two-zones, isolating living and sleeping areas and, in some cases, adults' and children's compartments (Masello, 1993). Breuer's house is a clear interpretation of a functional diagram, although others have interpreted it as a compositional strategy (Rowe, 1976: pp 128-130). His typology echoes much of the inter-wars European debate on housing, particularly in Germany.

The need to attend the demand for supplying the housing stock, not only deteriorating, but also insufficient for the increasing population of urban centres, raised the architectural interest in discussing the fundamental problem of housing, its minimum requirements, its functional needs and its mode of production. The minimum dwelling for existence, or *existenzminimum*, aimed at standardising housing to a mass production, thus attending public needs and not individual demands. It also aimed at establishing optimum parameters for house layout and use.

Amongst the *existenzminimum* experience, the work of Alexander Klein deserves particular attention (Bauer, 1934: 203-204). Klein was interest in differentiating movement in the house and, therefore, classifying and zoning activities. His scheme of a 'functional housing for frictionless living' shows how a rationalisation of the layout can be achieved. Klein compared his proposal with a typical nineteenth century layout, on the basis of flow-line diagrams (figure 1.2.). He traced the movement from the bedrooms to the toilet, the kitchen to the dining room and from the main entrance to the living or receiving rooms in different coded lines. The traditional 'bad example' is shown through the superimposition of different lines of movement, whereas the modern 'good example' isolates those lines of movement into different parts of the house, without crossing each other. According to Evans (1978), Klein's layout was metaphorically announced in its name, which implied that 'all accidental encounters caused friction and therefore threatened the smooth running of the domestic machine' (Evans, 1997: 85).

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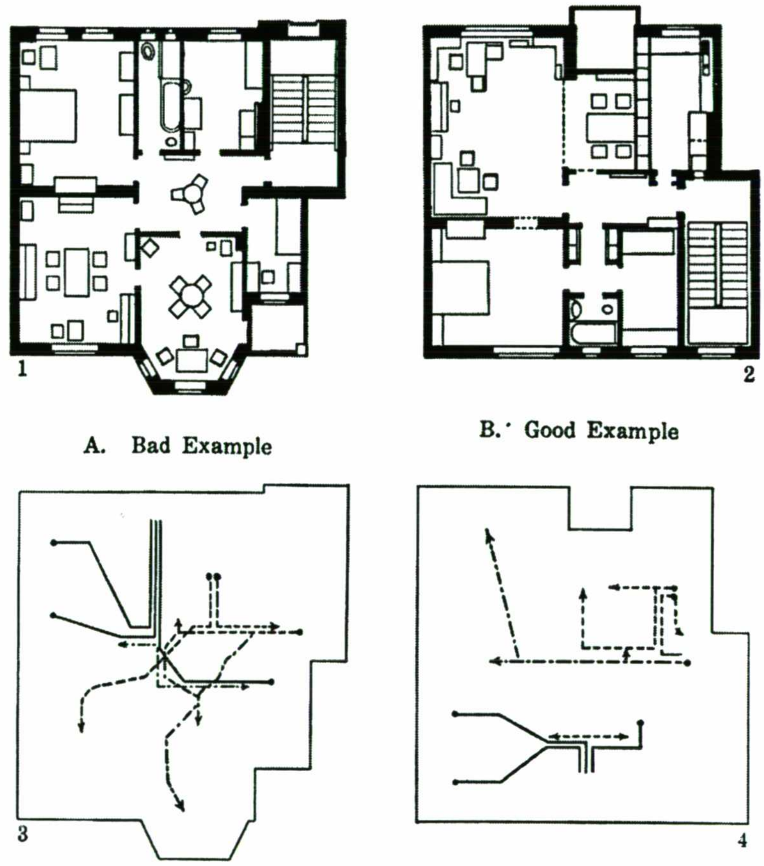
[3] For a synthetic discussion on the implications of modern domestic appliances in women's housework see, for example, *Mechanical Brides* (Lupton, 1993) and *Objects of Desire* (Forty, 1986).

By designing to accommodate specific activities to each room, assigned by means of built-in furniture and domestic appliances, the 'minimum dwelling for existence' contrasted with the traditional housing which did not assign specific activities to space (apart from the kitchen, defined by the sink), leaving its occupancy to the users' desire. By avoiding superimposition of different activities in the same room, modern architects expected to attend with more rigour the needs for a minimum existence. Not only that, the idea of a new modern lifestyle was implicit by changing the traditional domestic organisation, both in terms of building form and function. As a result, rooms and functions were zoned, and further isolation of inhabitants generated more rationality into daily life but, at the same time, with less flexibility.

FUNCTIONAL HOUSING FOR FRICTIONLESS LIVING



Mr. Alexander Klein, Berlin architect and planner, designs dwellings for real people to live in, and his plans result from careful study of people's necessary movements. These diagrams are from a special study which he made for the German *Reichsforschungsgesellschaft* (National Housing and Building Research Society), published in June, 1928.

Figure 1.2. Functional housing for frictionless living, by Klein, after Bauer, 1934

The *existenzminimum* experience produced a series of design handbooks, establishing parameters for minimum dimensions of rooms; ideal functional organisation for building types; technical requirements, such as fire prevention, vertical circulation, heating and all mechanical supports; and a series of typical layouts. Amongst these precedent based design handbooks, certainly the most influential one, at least in Brazil, was the *Architect's Data* by the Bauhaus student and later professor, Ernest Neufert (Neufert, 1980).

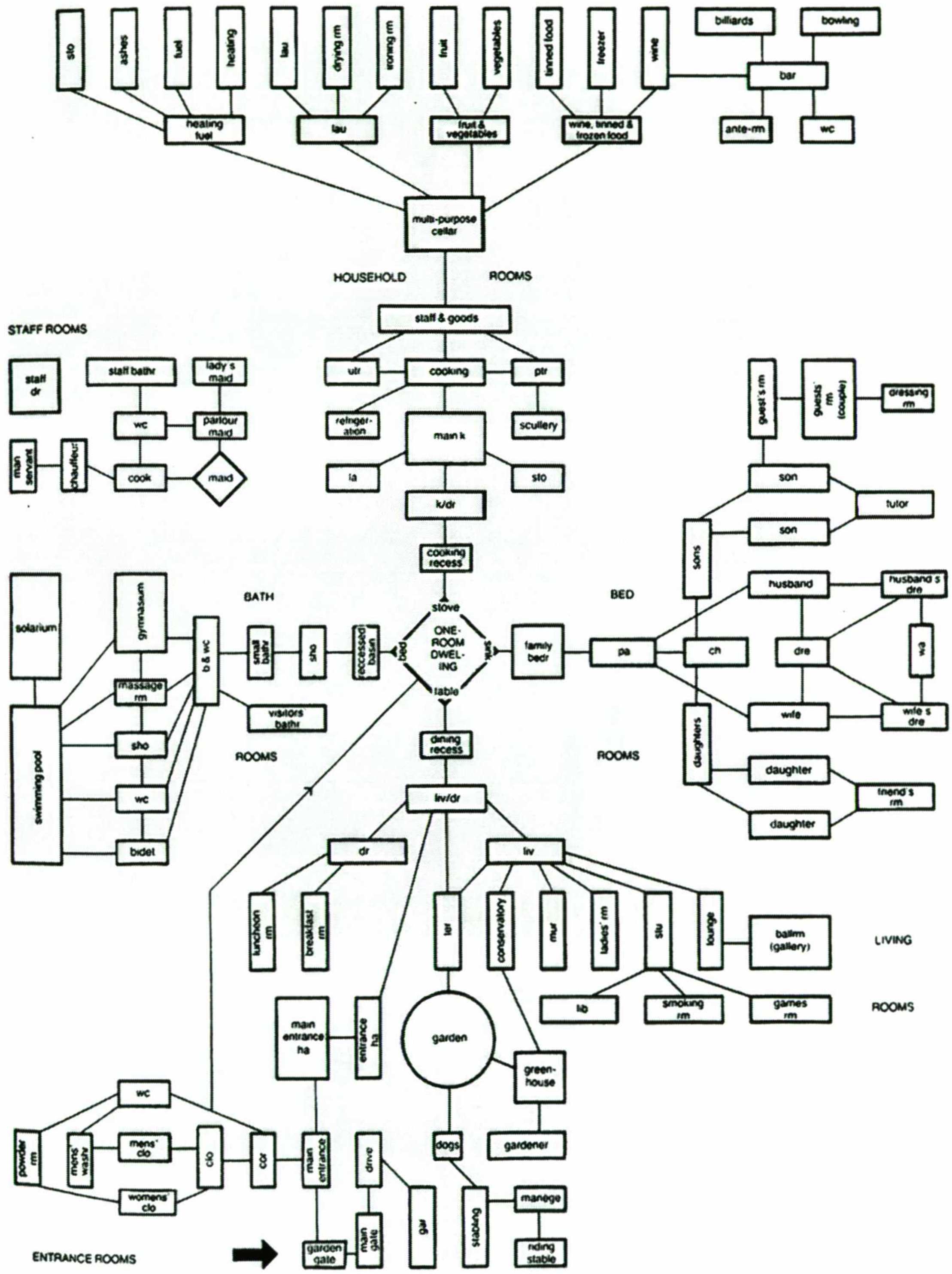


Figure 1.3. Subdivision of space, from 1-room dwelling to palace, after Neufert, 1980

In the section dedicated to house organisation, Neufert presents an interesting diagram in which he constructs housing organisation from a one-room dwelling to a palace (figure 1.3.). The zoned diagram grows centrifugally with the complexity of the program, but keeping intact the rigorous isolation of the domestic sectors. The diagram organises the living and receiving spaces, the private rooms and the household rooms in distinct quadrants. The staff rooms are disconnected from the main diagram, suggesting an independent outbuilding. The diagram also states age and gender inequalities in the family. Son's and daughter's accommodations, with their respective guest's rooms, are separated, placed symmetrically with relation to parent's premises.

The functional and diagrammatic nature of buildings are more emphatically enunciated by Hans Meyer. In his thesis *Building*, the architect proclaims that 'the functional diagram and the economic programme are the determining principles of the building project' (Meyer, 1970: 120). Moreover, in determining housing form, one should examine house's daily routine, which would produce a function-diagram of their occupants and their relation with the public areas. Technical features, such as heating, behaviour of materials, air and sun variables, would establish standard parameters for the new house.

The concept of method, enunciated by Viollet-le-Duc, permeates much of the architectural debate of the inter-war era, but it takes a more consistent theoretical form after the Word War II. Kennedy's *The House and the Art of its Design* (Kennedy, 1956) is a good representative of the type of work which intended to define a consistent design method.[4] The book is an exhaustive description and analysis of family life. The author establishes the ideal family structure and the profiles, or 'silhouettes' as he prefers, of the household members, including their daily routine. He states the inequalities between husbands and wives, establishes routines for bringing up children and the duties of servants who, according to Kennedy, are to be self-employed workers in the future (Kennedy, 1956: pp 35-72). In a sense, Kennedy's book follows the American tradition of domestic treatises, which has possibly started with the works of domestic economy by Catherine Beecher (Beecher, 1841; Beecher and Stowe, 1869)

Kennedy uses two concepts to design a house, one of privacy and the other of hierarchy. Privacy is seen as the basic need of individuals and family as a unit. Privacy is achieved in a hierarchical degree, from the public-entry area; to a semi-public-entertaining zone; through an operative or service area;

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[4] It is interesting to note that Kennedy's book was available at the library of Recife's faculty of architecture a few years after its publication.

reaching a semi-private zone for bathing, dressing; and finally to the private zone (figure 1.4.), not forgetting that a buffer zone, or zones, should be considered in order to allow a good performance of each sector (Kennedy, 1956: 133).

A significant part of the book is dedicated to the design method itself. Kennedy shows, in practical terms, how the analysis-synthesis process should occur. First, by the classification of activities according to a particular set of requirements; second, the grouping of similar activities, generating zones; third, by providing duplicate facilities to attend activities which may overlap others; and fourth, by defining barriers to guarantee the necessary independence of the sectors (Kennedy, 1956: 108). He also prescribes some tools. Correlation matrixes allow designers to analyse functional relationships and shape-free, or 'bubble', diagrams synthesise these relationships topologically (figure 1.4.). Indeed, the bubble diagram represents the basic topological dimension of the house, or the grounding layer from which the plan is developed.

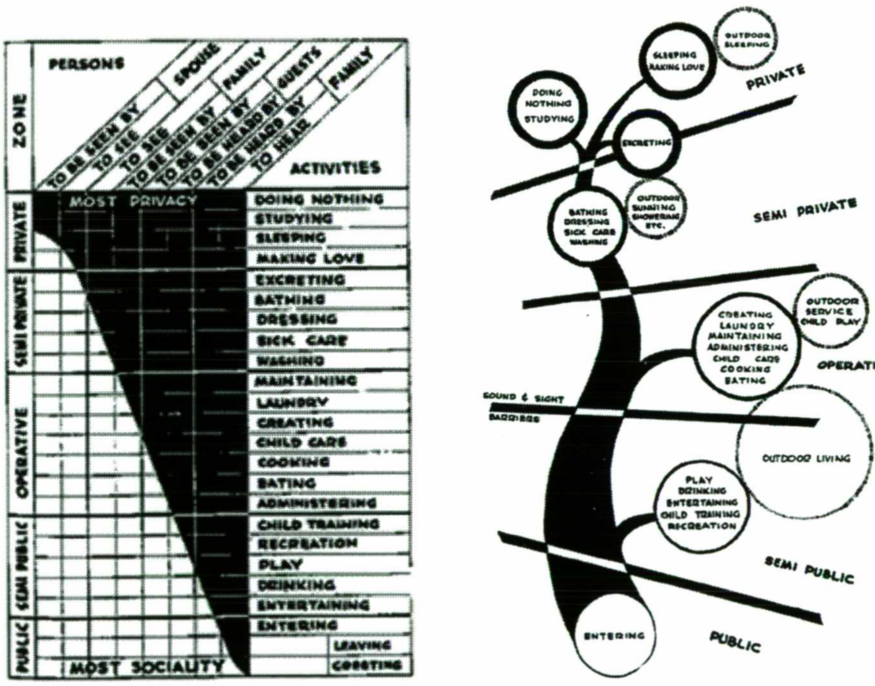

Figure 1.4. Housing diagrams, by Kennedy, after Kennedy, 1956

In Kennedy's method, the family structure and needs are the basis for house planning. The 'unbiased requirements' are listed, classified and grouped through a precise methodological procedure. However, the lack of empirical data and the sheer belief in the method itself, makes his book analytically fragile but strongly normative.

Kennedy's work is one of the many methodological attempts that preceded what has been called the 'design methods movement'. Its history can be traced in a sequence of events and publications (Heath, 1984; Johnson, 1994). Its inaugural moment was the Conference on Design Methods, held at the Imperial College, London in 1962 (Jones and Thornley, 1963), followed by the publication of Christopher Alexander's *Notes on the Synthesis of Form*, in 1964, which further develops some of the concepts present in *Community and Privacy* (Chermayeff and Alexander, 1963). A detailed discussion of the 'design methods movement' is beyond the scope of this thesis. Nevertheless, there are some relevant works concerning housing design which seem to continue Kennedy's line of research. For example, the classification procedure, the definition of desirable connections between rooms and the use of correlation matrix to 'weight' the nature of the relation between the functional-room-units are also seen in the work of Jones (Broadbent, 1988: pp 256-264). The method consisted of a three stage process: a) analysis-synthesis-evaluation, or identification of the building performance after inquiring the functional requirements, b) generating adequate forms to attend specifications and c) testing solution against requirements (figure 1.5).

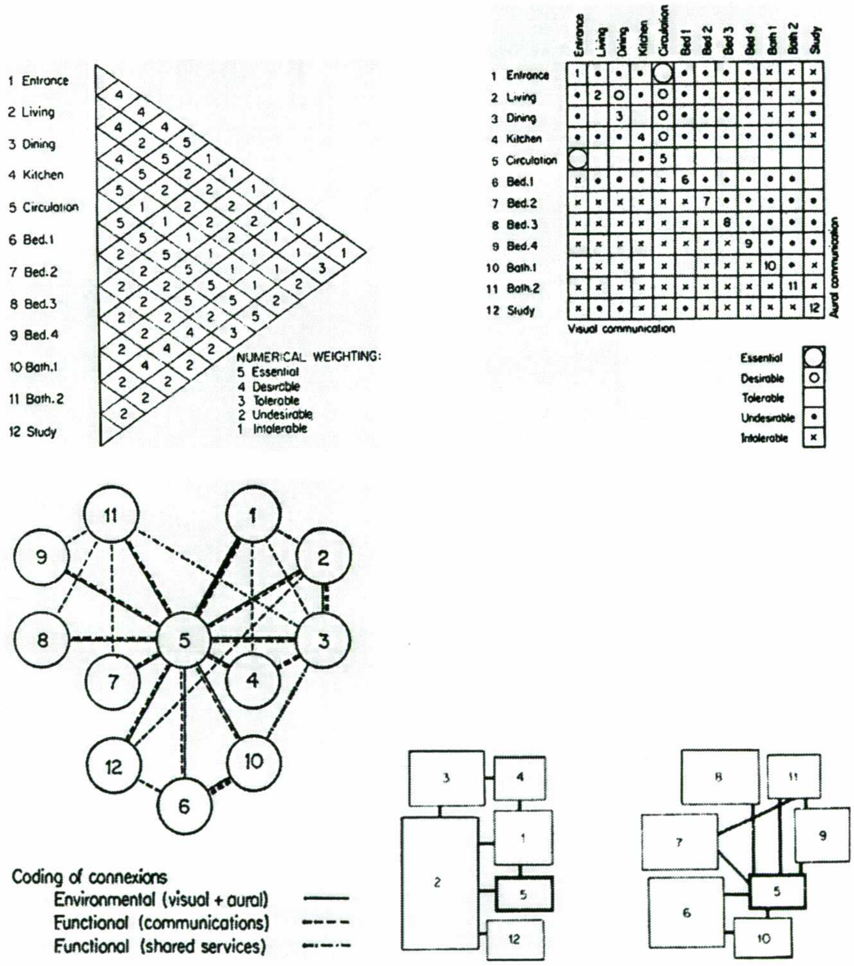

Figure 1.5. Jones' charts and graphs, after Broadbent, 1988

The analysis-synthesis method and social agenda converge in the work of Chermayeff and Alexander (1963). The authors claim the necessity for planning a new environment to combat the destruction of the nature and the cities, or as they prefer, the 'vanishing nature' and 'dissolving city'. The authors pledged for privacy and hierarchy, both at the urban and dwelling levels. The idealised model sustains a hierarchical model, from the more public areas to neighbourhoods, from neighbourhoods to local streets, from streets to the house itself.

The authors credit visual, sound and odour isolation, but essentially the control of access, as fundamental in domestic design. The adjustment of house design to attend the requirements for privacy are firstly achieved by constructing three clear sectors: one for parents, children and receiving zones. The privacy of these realms are guaranteed by means of 'locks' and 'buffer zones'. These transitional spaces are used in diverse hierarchies, isolating the house from the street, but also the domestic zones and the rooms themselves. (figure 1.6.). A good example of the authors' ideas is the court-house designed by Reynolds and Chermayeff (figure 1.7.). The plan fulfils all their essential requirements: 'entry lock to house; separate children's access; buffer-parents/children; lock to parents' bedroom; living room can be isolated; outdoor private spaces' (Chermayeff and Alexander, 1963: 227).

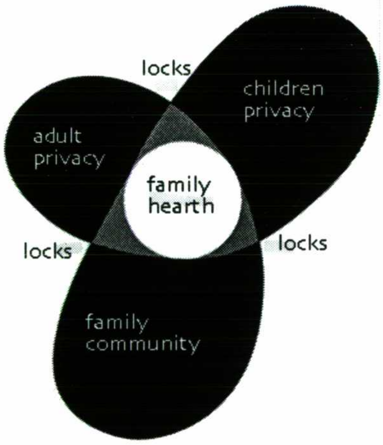

Figure 1.6. House diagram, by Chermayeff and Alexander, 1963)

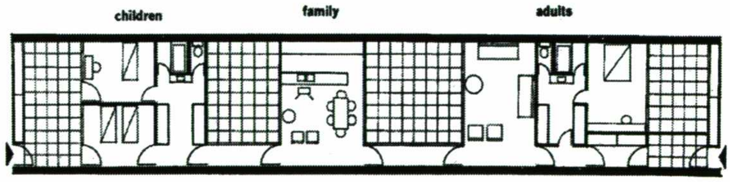

Figure 1.7. Court House, by Reynolds and Chermayeff, after Chermayeff and Alexander, 1963

The weakness of Alexander and Chermayeff's argument for a new social agenda for spacing family relations is the lack of empirical studies. The rehearsed choreography of family reunion and dispersion through secretive locks and passages, makes spatial a kind of family relation which is not universal, but ideologically biased by the authors' prejudices. Hanson (1998) interprets their proposal for social refinement as 'based on mutual esteem among family members rather than on the unmediated force of parental authority' (Hanson, 1998: 239). It is not surprising that what became significantly influential in their work was the idea of privacy and hierarchy as design principles and not the age/gender segregation of the members of the family. It was, it seems, the spatial means to achieve degrees of isolation, i.e., the idea of sectors, buffer spaces and locks, that made Chermayeff and Alexander's work so influential in the 1960s and 1970s.

1.2.4. Establishing identities and inequalities

The different outcomes of the 'design methods movement' and its predecessors, share the belief that 'a process from abstractly stated function to concrete architectural solutions could and should be a process of the analysis of the problem followed by a synthesis of the solution' (Hillier, 1996: 414). As they are mostly focused on design as a process, rather than on the result of the process itself, they tend to be analytically weak and normatively strong,.normative in the sense that they prescribe what should be done to ensure a successful solution for a problem. Darke (1979) also points out that most of the first theories on design methods were developed without observing the process of design in reality (Darke, 1979: 37). Therefore, it failed to reach the architects' studios.

Another criticism of the design methods comes from Mitchell. He sees the failure or inadequacy of the design methods because 'it conceives of social systems in an unrealistically static way, assumes a logical consistency that maybe illusory, and ignores the tendency of buildings to change the very patterns that they were designed to accommodate' (Mitchell, 1994: 200). He argues that the design cannot be summarised in Manichaen terms of fits and misfits, as proposed by Alexander (1964). Nevertheless, the influence of the design methods in architectural education cannot be denied, as Steadman explains:

The typical approach to design which characterised much of the work of the 'design methods movement', and which was taught in many architectural schools during the 1960s, implied a similar methodology to Alexander's, although of a more informal nature. First 'data' were collected and assembled into the 'programme', meanwhile all premature urges to define the form and shape of the buildings were suppressed. And then, through an analysis of this programme, the designer was encouraged to determine what form the logic of his analysis must produce; he had to find out 'what the building wanted to be' (Steadman, 1979: 207).

However there is a very distinct line which separates the theoretical adventure of methodologists like Alexander and the pedagogic methods used in Recife's school. Whereas Alexander's methods of fits and misfits, of requirements lists, and trials and errors, kept aside design speculation; in the architectural schools' design studios the preliminary formulation of domestic sectors were soon followed by an intense exploration of architectural form. As Bruno Taut idealised:

[Although] first, you come up with a logical diagram in response to site, orientation, landscape, and other such factors, this is truly a diagram - a scientific document which has nothing to do, yet, with architecture (...) It is important to wait until this diagram acquires life and thinking gives way to feeling. Only then is the hand set free to draw (Bozdogan, 1997: 180).

This section reviewed how the idea of sectoring was manifested in the history of architecture, both in the minds of the modern architects and of the architects of the past. The more analytically oriented modernism stated the importance of a design method to achieve the best solution for housing requirements. This phenomenon, as it was seen, assumed diverse manifestations, yet sharing the same fundamental belief. The resemblance between methods and techniques, expressed in the diagrams by Neufert, Kennedy, Jones, Alexander and Amorim, demonstrates their degree of kinship.

In the past decades, modern design theories and methods have been extensively questioned. Their fundaments have been argued on the basis of their theoretical flows, and their influence in architects' practice have been addressed. However, only a few studies have tried to understand the effects of the 'analysis-synthesis' methods to the spatial configurational of buildings (Hillier, 1996; Hanson, 1998), but none of them have look at how the concept of functional sectors have shaped domestic buildings. The particular form of materialisation of this phenomenon in Recife's dwellings is the intent of this investigation.

1.3. The method

Answering this question requires a method which is able to retrieve from the modern dwellings the influence of the described 'design methods' on their built form. In other words, the representation and analysis of the houses must be developed through a precise method which is able to describe the spatial characteristics of buildings and relate these properties to the ideas that have generated them.

Amongst the various theories and methods which have been developed in the past decades with both the intent to describe and analyse built form, space syntax has established itself in the field of architectural morphology[5] for placing the intrinsic relation between society and the man-made environment at its foundation (Hillier and Hanson, 1984). Furthermore, space syntax method offers a consistent and objective set of representational and analytical techniques which retrieves these social ideas present in the built form.

It is beyond the scope of this study to try to summarise the ideas that lie behind the space syntax theory. There is substantial literature on this subject, from its preliminary formulations (Hillier, Leaman et al., 1976) to its synthesis in *The Social Logic of Space* (Hillier and Hanson, 1984). A comprehensive description is also available in Steadman's *Architectural Morphology* (Steadman, 1983: pp 215-239). However, a general discussion is necessary to clarify the appropriateness of space syntax in answering the problems enunciated in this study.

Space syntax has been criticised by some scholars who argue the efficacy of the method in representing social phenomena (Samson, 1990) and by others of being deterministic (Lawrence, 1990). Some (Osman, 1993; Osman and Suliman, 1994) argue that the method itself is particularly oriented to representing Western buildings, therefore unable to develop cross-cultural studies. The authors also argue that the binary connectivity code does not allow for a fine-tune representation of a spatial system. Others (Teklenberg and Timmermans, 1992; Teklenberg, Timmermans et al., 1993) dispute the mathematical procedures which generates the fundamental syntactic measure of integration, a necessary procedure to allow comparative analysis of spatial systems of different sizes.[6]

However, extensive studies applying space syntax to a wide variety of architectural and urban problems, emergent from different cultural backgrounds, have shown how powerful space syntax is in representing, describing and understanding spatial phenomena (Hillier, 1996; Major, Amorim et al., 1997; Hanson, 1998). The measure of integration, for example, focus of the criticism referred above, has proven to be a powerful instrument to represent distances in graphs. Its application to the study of the urban systems has led to a consistent model for predicting urban movement (Hillier,

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[5] For a comprehensive discussion on the field of configurational studies, see *Architectural Morphology* (Steadman, 1983).
[6] A detailed account on the development of the mathematical equations is included in *The Social Logic of Space* (Hillier and Hanson, 1984), some of those are summarised in Appendix 1.

Penn et al., 1993) and to a theory that links urban structure and density, movement and land use (Hillier, 1996: pp 149-182).

Integration and other syntactic measures have also proved the efficacy of the method in retrieving social and cultural information from the built environment, overcoming space-time barriers, but mostly in providing the necessary insights to understanding and theorising spatial phenomena. Their application in archaeological studies (Bustard, 1997; Cooper, 1997; Shapiro, 1997), in cross-cultural investigations on vernacular and historical dwellings (Hanson and Hillier, 1979; Hillier, Hanson et al., 1987; Trigueiro, 1994; Orhum, Hillier et al., 1995; Orhum, Hillier et al., 1996; Hanson and Elgohary, 1997; Muhammad-Oumar, 1997; Hanson, 1998), in describing fundamental spatial properties of houses designed by architects (Irwin, 1988; Hanson, 1994; Hanson, 1998) and in investigating the relationship between space configuration of buildings and space use (Pepponis and Hedin, 1983; Hillier and Penn, 1991; Hillier and Penn, 1994; Hillier, Major et al., 1996; Choi, 1997; Penn, Desyllas et al., 1997) is a proof of the competence of space syntax in describing and theorising about spatial phenomena.

Space syntax can be shortly described as a '... set of techniques for the representation, quantification and interpretation of spatial configuration in buildings and settlements', and one of its fundamental ideas is that '... cultural ideas are objectively present in artefacts as much as they are subjectively present in minds' (Hillier, Hanson et al., 1987: 363). In other words, space syntax claims that buildings and cities are spatial complexes organised to attend social purposes and, therefore, the cultural and social values which brought them into existence are deeply embedded into their form. In this sense, social values are intrinsic aspect of buildings and cities, but mostly and uniquely expressed in the way space is tailored to assume these social purposes.

Considering that there is a socio-spatial nature in buildings, the most fundamental problem is how to retrieve these values from the physical artefacts, or how to define a descriptive theory of space. Hillier and Hanson propose a set of techniques to represent spatial elements, a consistent mathematical evaluation of the relation between these spatial elements; and the modelling of spatial patterns (Hillier and Hanson, 1984). The spatial elements are said to be of two dimensions: a convex, or bi-dimensional, and an axial, or one dimensional. A convex map is the set of discrete 'fewest and fattest' convex spaces, whereas the axial map is the discrete set of 'longest and fewest' axial lines. Another bi-dimensional element, the isovist (Benedickt,

1979) represent the visible area from a discrete point or from a convex space. These are not simple geometrical entities abstracted from the built form, but they directly relate to the form by which people occupy space, as 'people move along axial lines, form groups in two-dimensional convex elements, and see three-dimensional non-convex visual fields or 'isovists'' (Hanson, 1994: 676).

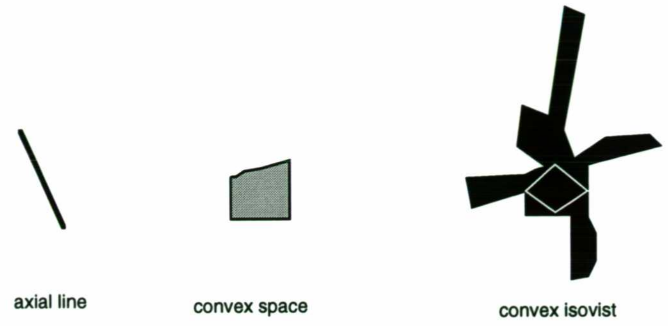

Figure 1.8. Spatial dimensions, after Hanson, 1994

Spaces are related to each other by means of adjacency, visibility or accessibility. However, how accessibility is defined has proved to be one of the fundamental ways by which social and cultural values are imprinted into spatial systems. This is because by controlling access to/from parts of the system, different categories of users are either isolated from each other, or carefully allowed to interact. The best form to understand accessibility in spatial systems is by building up a relational system in which spatial units are identified when seen as parts of a whole, or with respect to a configuration, understood as 'relations taking into account other relations' (Hillier, 1996: 1). When permeability between spatial units is represented as graphs, where the nodes represent the spaces and the edges the accessibility between the spaces, mathematical relations can be extracted and assigned to spaces.[7] Simple values, as the topological distance between nodes, called depth, or more sophisticated expressions, like the mean distance from one node to all others, called integration, are the precise and objective descriptions of the spatial configurations that allows a consistent identification of spatial-functional patterns. In other words, it measures consistencies in spatial phenomena.

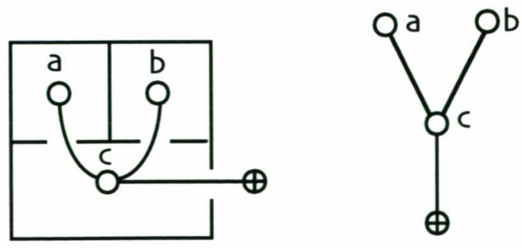

Figure 1.9. Justified graph

7 See Appendix 1.

The differentiation of these configurational properties of one space compared to another, and to all components of the system, has proven to be one the most powerful means to read the way in which social relations are imprinted into buildings. This is so, because human activity is manifested in space, therefore forming spatial patterns. In this sense, buildings can be understood as a pattern of differentiation or inequalities of the integration values amongst all space/function units of the building. The strength of these inequalities is measured by a formula adapted from Shannon's equation for measuring the entropy of a system, which is described in detail in Appendix 1. This 'difference factor' (DF) indicates to what degree these inequalities are expressed by the spatial configuration.

For example, in vernacular housing the form by which domestic activities like receiving guests, dining and cooking are numerically differentiated, may suggest certain forms of spatial patterns. It may draw the household together for dining, but isolate the reception area, making it more distant from all spaces of the complex. When inequalities in the numerical spatial values attached to key domestic functions are consistently found across a sample, than it is said to exist a cultural genotype - a functional 'genotype of ends' (Hillier, 1996). And the reason for this genotype is because established social and cultural values are unconsciously present in the minds of builders and inhabitants while defining house form and space-use. Hillier suggests that architects, by bringing design process to consciousness, tend to be independent of cultural genotype of ends. For that reason, architects' houses tend to explore space in its potential, rather than conforming space to certain social-functional patterns.

However, researches have shown that some architects tend to use space in a rather consistent form or style (Irwin, 1988; Hanson, 1994). For example, Irwin's (1988) comparative study of the houses designed by Loos and Corbusier identified that they did not present any strong functional genotype. Nevertheless, he identified consistencies in the way the architects used space, regardless of the activities assigned to it. Loos uses large and more uniform isovists to reinforce the intelligibility of the houses, whereas Corbusier invests in radical changes in the visual fields, to reinforce axiality in the houses. This consistency in the way space is handled by architects is called 'genotype of means' (Hillier, 1996: pp 438-445). The assumption that vernacular houses tend to follow functional 'genotypes of ends', whereas architects' houses tend to follow 'genotypes of means' is one of the established concepts that pervades syntactic understanding of domestic buildings.

It has already been pointed out in the introduction of this thesis that modern housing became a well established tradition in Brazil. Because of this, it may be possible that the boundaries between culturally and socially established spatial-functional patterns and the intrinsic experimental nature of architecture have been blurred. Therefore, it is possible that configurational consistencies may be found in the modernist house as a consequence of the embedding of social practises in the design process. Furthermore, it is also possible that some forms of spatial organisation present in vernacular and historic houses of Recife have permeated the configuration of modern houses. In this sense, modernism might have absorbed not only formal elements from the historical repertoire, but also some forms of domestic organisation. Therefore there is a need to understand how both modern and historic dwellings were spatially organised into sectors.

The observation of such phenomena is paramount in this research for two reasons. Firstly, because it questions a fundamental assumption of space syntax field. Secondly, because if consistent functional patterns are found in Brazilian houses, then similar phenomena may occur in other environments in which modernism established itself as a new tradition. Therefore, the application of space syntax methods and theory are justifiable both as a scientific tool for spatial analysis, and also to question one of its theoretical assumptions, the building/architecture paradigm as posed by Hillier (1996).

1.3.1. On the representation of houses

The 'space syntax toolbox' provides the researcher with representational and analytical techniques to describe spatial configurations. As Hillier points out, 'prior to the researcher setting up the research question, no one representation or measure is privileged over others' (Hillier, 1999: 1). It is by applying and testing out representational procedures that the researcher would identify the most suitable to capture the 'logic of a particular system'. In the process of uncovering the spatial nature of Recife's dwellings, different forms of space representation were explored. However, as the research problem is focused on how domestic activities assigned to space are agglutinated into spatial-functional sectors, convexiality was established as the prior spatial dimension to be observed.

The method for representing spatial convexity in this study deserves some clarification. A convex map represents, as already said, a discrete set of 'fattest and fewest' convex spaces in any configuration. However, this concept of convex partitioning presents some classical paradoxes, because 'fatness' is not always a sufficient requirement to break up a spatial system in the smallest number of units. The paradox presented by a symmetrical 'L-shaped' space (figure 1.10) is one example of the imprecision of the convex definition.[8]

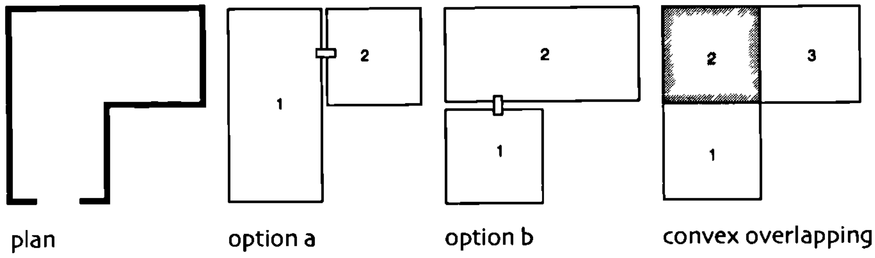

Figure 1.10. The 'L-shape' paradox

To overcome these difficulties, the convex representation used in this research observes the houses tri-dimensionally, and not bi-dimensionally. For example, convex boundaries are induced by differences of level and ceiling height. Similarly, beams, pillars and built-in furniture trace imaginary contours in space, thus generating tri-dimensional convex units. When tri-dimensionality is not enough to differentiate convex units, and when the classic 'L' shape problem appears, the observation of built-in furniture can otherwise be another source of convex delimitation. In a more improbable situation in which neither of these might occur, the convex overlapping paradox is solved by tracing a diagonal line to generate two convex spaces (figure 1.11.).

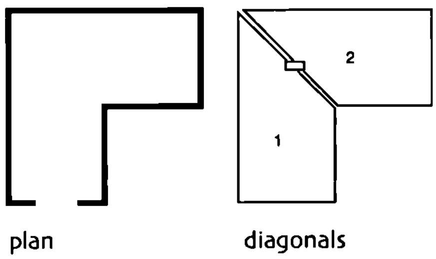

Figure 1.11. The 'L-shape' paradox: using diagonals.

This procedure was used to represent both indoor and outdoor spaces. The representation of houses' outdoors as a complex of convex spaces is justified by the belief that outdoors activities in Brazilian houses are as significant as indoors activities. Therefore, the way the outside is convexialy arranged responds to requirements as important as those which shaped the house's form.

Outdoor spaces poses difficult problems for representation for their openness and spatial continuity. Verandas, pergolas, differences of level and pavement lines are the physical evidences used for establishing convex partitions.

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[8] For a long discussion on the convex representation and some of its paradoxes see *Intelligent Architecture* by Penn, Conroy et al. (1997: pp 30.2-30.6) and *On the description of shape and spatial configuration inside buildings* by Peponis, Wineman et al. (1997: pp 764-770).

Another important observation concerning the outdoor spaces is the existence of independent entrances to the house. Generally, independent gates leads to clear and differentiated convex spaces; however, there are cases in which this does not occur; instead, differences in the pavement, separated by green areas, isolate both accesses. In these cases, independent entrances would correspond to different convex spaces. This differentiation is physically perceived by the formal or informal treatment that each part of the open area receives.

The representation of ramps and staircases also deserves attention. External staircases, which connect gardens and verandas, or kitchens to backyards, are represented as single convex spaces when they exceed four steps, regardless of their form. If they have less than four steps, they are considered as simple differences of level. Internal staircases are more complex and appear in a variety of shapes and types. When the staircase is enclosed and the two flights are visually isolated from each other, the staircase is represented as two convex spaces. If the landing leads to any other space, each flight would be considered as a convex unit, as well as the landing itself. If otherwise the staircase is open, it is counted as a single convex space. The same procedure is used for ramps.

Open plan commonly generates lumps of space, such as recessed doorways or 'leftovers' of irregular shapes. These spaces are not considered in the convex map, unless if they exceed 1,0 m2 of area, with at least 1,0 m wide. In these conditions, spaces are unsuitable for occupational activities but are efficient as buffer spaces. Otherwise, smaller units would only overweight the syntactic analysis.

The representation of the visual fields of the houses also needs to be specified. Visual fields or isovists were originally proposed by Benedickt as the representation of all visible points from a vantage point in space, with respect to an environment (Benedickt, 1979: 47). His concept was later expanded to a 'convex-isovist', or the collection of 'point-isovists' generated by a diamond-shape polygon, inscribed in the convex space (Hillier, 1993; Hanson, 1994). For the purposes of this study, isovists were drawn from complete convex spaces, therefore representing all their possible 'point-isovists'.[9]

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[9] The representation of visual phenomena has thereafter been extensively extended. For example, Irwin's (1988) line isovist, takes all the visible points while moving along an axial line. Hanson and Major (1997: pp 21-24) describe other forms of visual representation like the façade and wall isovists.

1.4. The sample

In any empirical research the selection of the sample is of fundamental importance. The main concern in selecting Recife's houses for this study was to be generous in diversity, but consistent in the information available for each exemplar. Diversity meant the inclusion of all possible dwelling types - detached, semi-detached and terraced, ground floor and multi-storey high; designed by different professionals - architects, draftsmen and engineers; and from different social stratum. Consistent information, meant availability of certain geometrical and morphological information of houses' fabric, which was useful in cross comparisons.

There were two main constraints in forming the modern and historic samples. The first was the small number of published works on Recife's domestic architecture. This guided the investigation towards public and private archives, of sometimes difficult access, either for bureaucratic reasons or for lack of maintenance and organisation. The second was the limitation of time, which defined the method of data gathering. Priority was given to collecting original plans of modern houses because no other study has previously compiled and investigated them. Public archives were the main source of data, as architects' offices seldom have organised archives. As time was consumed by selecting the modern sample, pre-modern houses had to be assessed through second-hand sources, mainly because historical data are more restricted for access and reproduction. Efforts were made to reach second-hand sources (unpublished thesis and architectural studies) which used consistent methods of collecting data and offered enough material for the research.

1.4.1. The modern sample

The first modern exemplars to be found in Recife were built in the 1930s, but they were mostly official and public buildings. It is, therefore, the post-war panorama that will be of interest. It was then when modern concepts spread out, embraced by a new generation of architects and by an emergent middle class, that the suburban modern house was the highest aspiration of wealth and progress. A period of an intensive and creative modernist experience lasted until the 1970s, when its strength started to fade. Dwellings ceased to be the experimental laboratory for architects and the clients, who gradually moved to flats. The research is therefore focused on the period between 1950 and 1970, including examples immediately before and after it, allowing a better understanding of the development and maturing of Recife's modern architecture.

A preliminary sample was taken from a broader research on modern architecture of Recife (Amorim, 1989a; Amorim, 1993), which identified and collected the plans of significant buildings from the archives of the municipal planning regulator, Urb-Recife (*Empresa de Urbanização do Recife*). This original sample might have constituted a perfect set for developing this research, for its size and representativeness of domestic architecture of the city. However, during the field research carried out in 1996, it was observed that a significant number of houses was either demolished, to give land to tower blocks,[10] or had its use changed, mostly to commercial activities.

A second and final sample was then defined, by extending the research to Urb-Recife's archives and to architects' offices, ensuring a better coverage of the modernist panorama of the city. The process of selection was twofold. Firstly, houses were visually identified in the urbanscape and their plans searched at Urb's archives. The success of this operation was limited because of archives' losses, caused by lack of maintenance and occasional floods suffered by the city.[11] A complementary procedure was used, which consisted of a random selection of plans in the archives, and later a double check to discover if they had been built or not. Secondly, seminal projects, constantly referred to by architects, historians and critics (Santana, 1969; Silva, Amorim et al., 1981; Acayaba and Ficher, 1982; Silva, 1988; Amorim, 1989b; Wolf, 1989b; Silva, 1997) were included in the sample. Likewise, published dwellings were also included in the sample. They were published locally at *Página de Arquitetura*, the *Instituto de Arquitetos do Brasil-Departamento de Pernambuco*'s official media, and at national and regional architectural magazines. Under these conditions, the city's limits were not considered. In total, 287 plans were collected, reduced to 204 after eliminating the cases which did not present consistent data on the morphological, geometrical and functional properties of the houses.

1.4.2. The pre-modern sample

Difficulties in collecting the modern sample reduced the possibilities of exploring sources on historic buildings, for example, the *Divisão de Esgotos of the Companhia de Águas e Esgotos de Pernambuco - COMPESA*, the *Instituto Histórico Arqueológico e Geográfico de Pernambuco*, and the *Instituto do Patrimônio Histórico e Artístico Nacional*. These difficulties determined the use of previous studies on historic houses of Recife which compiled, through

[10] The substitution of houses by tower blocks is one of the most profitable markets in Recife, since the 1970s.
[11] The Urb-Recife second and third departments were the most affected by floods.

reliable methodological procedures, a significant number of plans (Trigueiro, 1989; Silva, 1990; Trigueiro, 1994).

Trigueiro's works are more concerned with urban and suburban eclectic houses, built amid the second half of nineteenth century and the first quarter of this century, while Silva's thesis focuses on the patriarchal rural dwellings, aggregated to the sugar cane production. Silva's work provided some insights on space use and historical data, but none of the plans were useful, as this research focuses on urban dwellings.

The next step in defining the historic sample was the selection of a sub-set of plans from Trigueiro's PhD Thesis, *Change in Domestic Space Design* (Trigueiro, 1994). However, the plans presented on her thesis were somehow incomplete, because the author concentrated her study on the houses' minimal living complex and, in most of the cases, both sites and outbuildings were not included. This problem was partially solved by assessing some of the original plans collected by Trigueiro, and selecting those which fulfilled the requirements of this research.

One problem remained unsolved, however. The available historic plans were originated from a survey carried out for a complex sanitation project for Recife in the 1910s. Therefore, the plans account for the conditions of the houses in that period. Their original features might have been changed to adapt to new social conditions or owners' requirements, for example, the extension of the house to accommodate bathroom and kitchen. With these limitations, the plans were analysed with great care. Functions were only attached to rooms when information was available or when guesses would not compromise the results. The literature review on nineteenth century Recife, compiled in chapter four, was paramount to formulate a consistent interpretation of the plans.

Chapter Two
Architects' Recife Houses: a diagnostic study

The previous chapter dealt with the origins and manifestations of the idea that the domestic environment should be organised into spatial-functional sectors. It also placed at the core of this investigation the question of identifying the forms by which this concept was realised in Recife's modern houses. This idea is considered in this chapter, which draws a diagnostic study of how the sectors' paradigm was applied to the houses which architects designed for their own use. The motivation for such study is the assumption that architects' houses represent the purest and finest possible expression of architects' beliefs, given the absence of others' constraints and 'misconceptions'. It is expected that, by analysing the morphological nature of Recife architects' houses, one may identify how the sectors' paradigm has influenced design process.

The chapter starts with a short discussion on the nature of the architect's house and its important role in expressing modernist revolutionary concepts and new lifestyles. The method of analysis is introduced in section 2.2, where a sub-set of representational techniques is selected from the 'space syntax toolbox' and a novel technique which allows the representation and analysis of the sectors' configuration of the dwellings is described. The sample is described in section 2.3., and then scrutinised, in section 2.4, observing their accessibility and visibility patterns, but particularly their sectors' arrangements. The data is revised and discussed in section 2.5., characterising the general properties of the dwellings and establishing common architectural features among the sample. The chapter is concluded, in section 2.6., by stressing the importance of the sectoring procedure in shaping architects' Recife houses.

2.1. The house of the architect as a statement

During the development of modern architecture, many architects designed their houses as architectural statements. Some expressed a revolutionary aesthetic, others introduced new materials and building techniques. But their statuses are recognised for proposing new lifestyles, challenging the conservative nineteenth century domestic organisation. The unique opportunity to define the brief, the freedom to explore new spatial forms and state how and in what circumstances householders should live, and furthermore to express architect's design philosophy, are perhaps the reasons to expect that these dwellings should have a special meaning. In addition, they are also extensions of authors' personalities, expressing more than their architectural ideas, but the designers themselves. This association between author and work is likely to be seen in other pieces of architecture, but none has the aura of architects' own dwellings. Indeed, the house of the modern architect is surrounded by a kind of mystique.

However, if these buildings are indeed different, one has to remember that architects are social beings embedded in a system of beliefs to which they are unconsciously related. Therefore, the house of the architect may represent designer's ideologies, but is also a struggle between an unconscious commitment to society and a break-through in tradition and convention. There is a tendency to generalise architects as challengers of cultural and social establishments, using architecture to question social practices and taste. Despite this general assumption, some architects acquire professional recognition by sharing and expressing established social values. This fact does not deny Newton's suggestion that architects 'believe that better buildings will make better lives for the people who live and work in them' (Newton, 1992: viii), reminding us that architects' houses, as prototypes of their ideologies, can be revolutionary or conservative.

The house of the architect forms a tradition in architecture (Newton, 1992; Zabalbeascoa, 1995). As referential types, architects' dwellings stand out from the tradition consolidated by the 'builders' guide' type, like Asher Benjamin's *The American Building Companion*, Downing's *The Architecture of Country House* (Jandl, 1991: 7) , *Godey's Lady's Book*, *Ladies' Home Journal* (Searing, 1989: 107) and their Latin-American version, *Mi Casita*, because they are personal statements. They also differ from architectural and moral treatises like Catherine Esther Beecher's books on domestic economy (Beecher, 1841; Beecher and Stowe, 1869), which proposes detailed plans for comfortable, practical, and morally and physically hygienic houses. The same could be said about Kerr's *The Gentlemen's House* (Kerr, 1864), already discussed in Chapter 1. The architects' houses also differ from the 'demonstration dwellings' tradition, inaugurated by Robert's Prince Albert Model Cottages, showed at the London Great Exhibition of 1851 (Searing, 1989: 108), because they are conceived as models to be reproduced in mass. Architects' houses are individual and unique, perhaps aimed to become a type, but never as a model to be reproduced.

If the architects' houses are different from the conventional housing, the prototypical or the reproducible model houses, one has to consider that financial restrictions and pragmatic considerations may restrict freedom and reinforce practicality in their design. Therefore, achieving the best results with minimum resources suggests that some houses may be closer to a 'shelter' than to an ideological statement. In this sense, generalising about the nature of architects' houses seems paradoxical, being either practical or speculative. Nevertheless, the house of the architect becomes a reference if it generates sequential interpretations by their authors, meaning social acceptance, or by their fellow colleagues, indicating professional reputation.

Critical literature seems to recognise this aspect. For example, the Rietveld-Schröder House (1924)[12] is praised for synthesising and divulging *De Stijl* movement, representing Van Doesburg's *Sixteen Points of a Plastic Architecture*, being 'elementary, economic and functional; un-monumental and dynamic; anti-cubic in its form and anti-decorative in its colour' (Frampton, 1980: 145). Similarly, but critically endorsed for its radical proposal for an alternative lifestyle, is Schindler's cooperative studio-residence (1921-22). Fascinated by the American wilderness and the mild Californian weather, Schindler conceived a 'campfire house', with courtyards as living, cooking and dining areas and bedrooms as 'sleeping baskets' on the roof (Steele, 1996: 16). The integration between interior and exterior, the richest of modern themes, makes in this house one of its earliest and happiest attempts. To these houses an endless list could be added, which would certainly include the houses of Alvar Aalto, Philip Johnson, Charles and Ray Eames, and Richard Rodgers. They all express the same urge to explore architectural possibilities and state new lifestyles.

The literature on Brazilian modern architecture attests the importance of architects' houses in the development of modernism in Brazil. Historians consider the house of Russian émigré Gregory Warchavchik the first Brazilian modern building,[13] in 1927 (Ferraz, 1956). The house inaugurated a tradition in Brazilian architecture, which has in Rino Levi's introspective houses (Levi, Burle-Marx et al., 1974: 58-59; Bruand, 1981: pp 273-274), Bo Bardi's transparency and structural expression (Bardi, 1993: pp 78-83), Bratke's modular composition (Bruand, 1981: pp 282-283), Niemeyer's free-form architecture (Papadaki, 1956: pp 69-77; Segawa, 1997) and Mendes da Rocha's spatial integration (Xavier, Lemos et al., 1983: 77; Acayaba, 1986), some of its best examples.

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12 Although the house has been publicised as being designed by Rietveld for Mrs Truus Schröder-Sharäder, it was in fact a joint design (Overy, Büller, Oudsten, & Bertus, 1988: 20).

13 For a critical account of the official historiography of Brazilian modern architecture see *A Constituição da Trama Narrativa na Historiografia da Arquitetura Moderna Brasileira* (Martins, 1994)

Similarly, Recife's architects used their houses to express design philosophy and lifestyle. Perhaps one of the first and finest examples is Borsoi House (1955). It expresses the Carioca formalist trend, where the architect was trained. From the same period are Reynaldo (1954) and Norberto (1958) houses (figure 2.1.a). The 1960s were more prolific in the number and quality of dwellings. From Domingues' embodiment of tradition and modernity to the brutalist (Banhan, 1966) aesthetics of Gomes-Trajano House; from the modulor based Agamenon-Andrade House to the compact Pessoa de Mello House (figure 2.1.b); all review Recife traditional domestic ambience. The 1970s stretches some of the 1960s concepts, but the renovation of old colonial houses by architects was a particular phenomena to be noticed. The gentrification of the colonial city of Olinda and old quarters of Recife occurred in similar circumstances to the occupation of London working-class houses, in the same period (Hanson & Hillier, 1982).

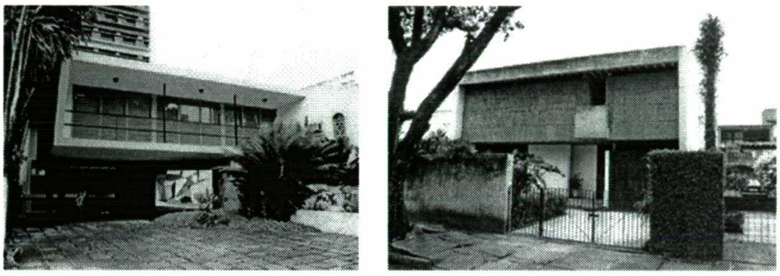


Figure 2.1. Architects' houses: a) Norberto house, b) Pessoa de Mello house

2.2. The method

The diagnostic study to follow applies space syntax techniques to uncover the spatial characteristics of Recife architects' houses. It does so at two levels; first, by describing the houses in their convex dimension, and second by observing their sectors' organisation. This section details the methodological procedures used to describe the convex dimension of the houses, captured in their accessibility and visibility patterns. It also introduces a novel syntactic technique which describes houses' sectors' organisations. The analyses were developed with the help of the computer programs *aNewWave*, version 1.5 (Dalton, 1990a), *Netbox*, version 1.0d1 (Dalton, 1990c), *aaNetbox4.1*, version 2.0d1 (Dalton, 1990b), and *Pesh*, version HyperHyper (Dalton, 1997).

2.2.1. Selecting tools from the 'space syntax toolbox'

The first analysis is developed according to the traditional syntactic method, following the procedures presented in Chapter 1. It is focused on the convex dimension of the houses and explore their configurational properties. First the analysis looks at the degree of ringiness of the houses by counting the ratio between the number of spaces and the number of connections in the system. The 'space-link ratio' (Hillier, Hanson et al., 1987) is expressed by the equation,

$$SL = \frac{l-1}{s} \qquad [1]$$

where *SL* stands for space-link ratio, *l* for the number of links and *s* the number of spaces of a given system. A tree-like system has a space-link ratio of 1. Ringy systems have values above 1.

Another important way of describing the houses is by assessing how open or compartmentalised their layouts are. This is done by counting the number of enclosed spaces, i.e., rooms that may be isolated from the spatial system by means of doors and walls, which corresponds to a single convex space. The ratio between the bounded spaces and the total number of convex spaces indicates the degree of openness of the layouts. Systems with high 'bounded-convex ratio' are more compartmentalised, whereas systems which present low values are more convexially articulated. The bounded-convex ratio is expressed by the equation,

$$BC = \frac{b}{c} \qquad [2]$$

where *BC* stands for bounded-convex ratio, *b* for the number of bounded spaces and *c* for the total number of convex spaces.

The analysis also looks at the space-use pattern of the houses, i.e., the number of transitional and functional used spaces. This can be expressed by the 'degree of functionality' (DF), which is the ratio between the number of use related spaces and the total number of spaces, expressed by the equation,

$$DF = \frac{f}{c} \qquad [3]$$

where *DF* stands for degree of functionality, *f* for the number of functional spaces, and *c* for the total number of convex spaces. Low values indicate a 'transitional oriented' plan, whereas high values indicate a 'functional oriented' layout.

The syntactic data is scrutinised by observing the most integrated spaces of the houses, and assessing their space-use condition, if transitional or functional, and the sectors to which they belong. The integration values are expressed in RRA, meaning that low values indicate highly integrated spaces, whereas high values indicate segregated ones. The set of 25% most integrated spaces form the configurational centre of the house, and is called integration core. Its size, composition (in terms of space-use and assigned activities), and location (if shallow or deep) are important properties to be observed.

Complementing the permeability analysis, visibility data is collected and analysed configurationally. Visual integration is the most important measure, expressing the relative visual domain of one convex space in relation to the system. This measure is based on the visual connectivity of each convex space, or, the number of convex spaces seen from a given space . Visual connectivity is a topological measure and therefore does not account for the area or shape of the visible area. It also does not represent assymetries in the visual fields. For example, from a mezzanine one sees the whole space below, whereas the contrary is not true. But from the space below an observer intuitively is aware of the existence of a space aloft. Figure 2.2. shows how visual connectivity is calculated. Convex isovists are drawn and the number of convex spaces covered by them are counted, representing their degree of cognition of the surrounding spaces. A more complex metric connectivity could be used, based on the ratio of the area seen over the total area of the room, but the unavailability of computational tools oriented the research to use this simplified representation. Notwithstanding its limitations, the visual connectivity gives an interesting description of visibility in buildings.

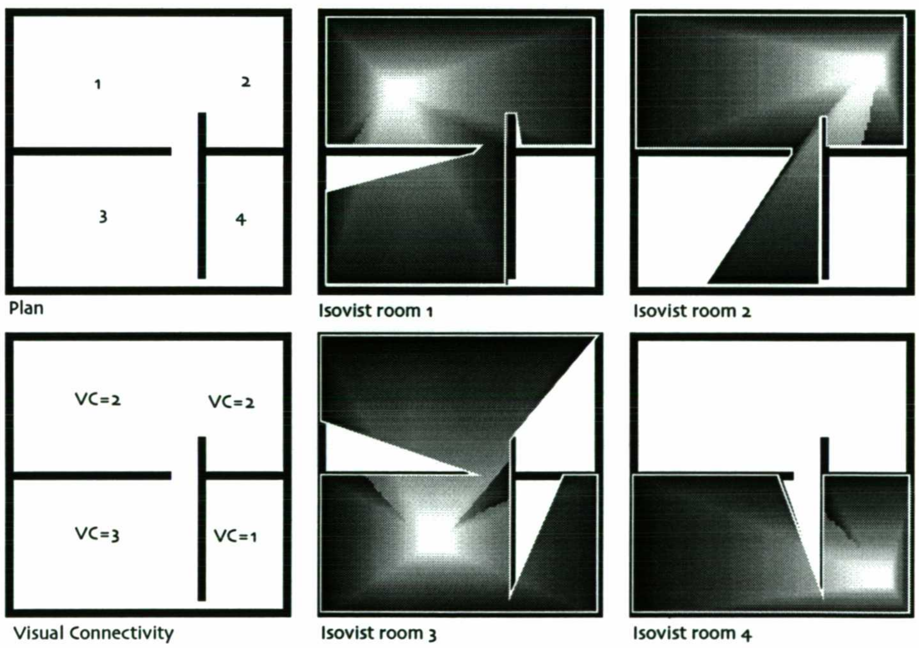


Figure 2.2. Calculating visual connectivity

The 'level of cognition' of the houses can be measured by the correlation between integration and visual integration. A strong correlation indicates that accessibility and visibility are combined in an orderly manner to make the whole complex intelligible from its shallowest parts, but also to reduce information available at its deepest spaces. On the other hand, a weak correlation indicates a heterogeneous spatial system in which visibility and accessibility are unevenly distributed. In this circumstance, understanding of the whole from its parts is less likely to occur, therefore moving about the system becomes essential. In sum, a high degree of cognition offers spatial knowledge of the house's parts, whereas low degrees of cognition cause a more dynamic experience of the house.

2.2.2. A syntactic representation of sectors

The interest in understanding the influence of a design method in actual buildings, poses a problem of representation: how can sectors be represented, described and analysed? To answer this question, a novel representational technique was developed. This technique, called 'sectors' analysis', consists of three steps. Firstly, it identifies each functional and transitional space with the sector which they prescriptively ought to be attached to, i.e., whether they belong to the social, service, private or mediator sectors. Secondly, it observes whether the classified spaces form continuous functional fields. Finally, it develops a series of syntactic analysis, aiming at characterising the configurational properties of the sectored dwellings.

The classification of some spaces - living room, bedroom or kitchen, leaves no doubts to which sector they belong to. However, the occasional superimposition of activities in the same space may generate some conundrums in the classification process. The solution is given by the spatial organisation itself. If there is a continuity between established categories of spaces and a space in question, the latter would be amalgamated into the category. If, on the other hand, the activity is spatially isolated, perhaps by means of a mediator space, then it would constitute an independent zone.

2.2.2.1. Representing

Figures 2.3. and 2.4. show, step-by-step, the sectors' representation of Melo House (M69). After generating a convex break up of the house, a justified graph is drawn, taking the exterior (public space) as its root. The second stage labels each convex space by the sector to which it belongs. Note that the private spaces (4 to 8) are grouped in a deep and isolated sub-complex, accessible through space 2. The social units (1 and 12 to 15) form a ring connected to the exterior, to the service spaces (3, 9 to 11, and 16 to 21), as well as to space 2, the mediator space. These functional sub-complexes are then reduced to single nodes, which are connected to each other by the remaining links.

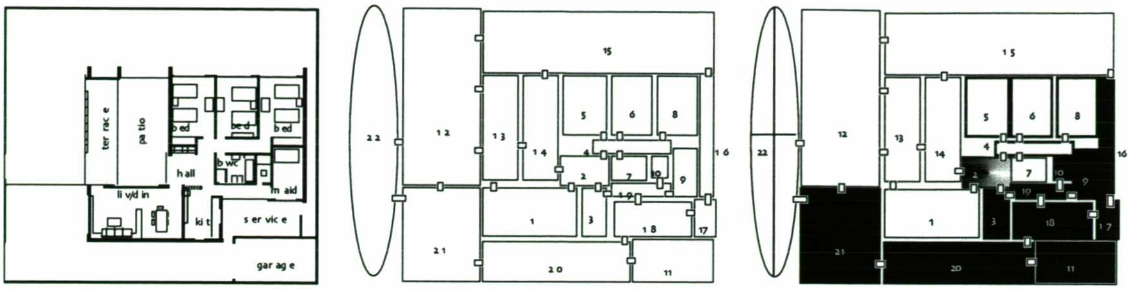


Figure 2.3. Melo House : a) plan, b) convex break up

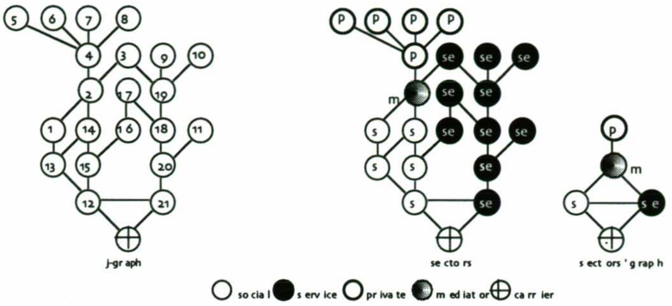


Figure 2.4. Melo House: justified graphs

The same procedure can be repeated to represent the house in different circumstances. If one is interested in observing the indoor activities, then the outside can be taken as a carrier space. Figure 2.5. shows how service units are clearly separated into two realms, one at the interior of the dwelling and the other, as an outbuilding or *edícula*, only accessible through the garden. On the other hand, if the interest rests in understanding the sectors' configuration of house's interior, the indoor system can be isolated (figure 2.6.). The graph represents the complex from the inhabitants' viewpoint showing the importance of the mediator in binding the household together.

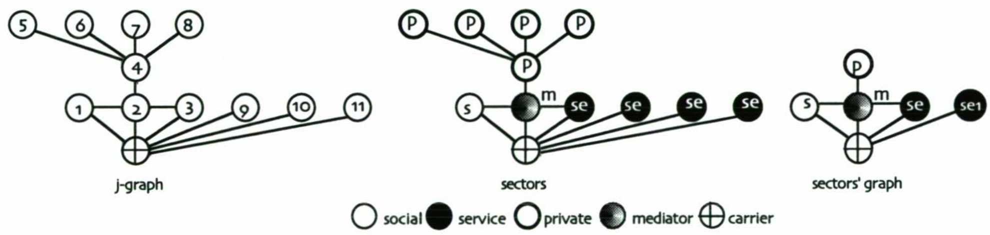


Figure 2.5. Melo House: justified graph with the outside spaces as a carrier space

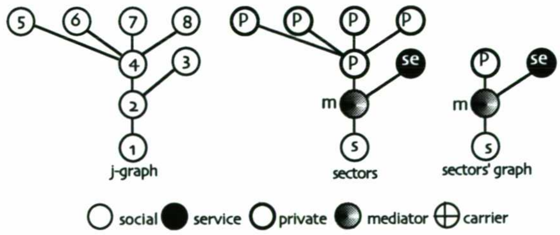


Figure 2.6. Melo House: justified graph of the indoor spaces

However, these two alternative forms of representation are more limited. They do not capture how the whole complex is related to the public space, for example, if the access to the house is socially categorised (social/service) or not. And this seems to be quite relevant in understanding how the household is composed, because independent access invariably leads to independent sectors. Moreover, the outside spaces of the Brazilian houses are extensively used throughout the year, functioning as natural extensions of the house itself. The exclusion of the outside spaces would mislead the true nature of these dwellings. Indeed, the analysis of the sample confirmed that by classifying the outside spaces into sectors and including the exterior as a root for the graph proved to be the more reliable and complete form of representing the sectors' structure of the houses. Therefore, the model used to represent the sectors' structure in this thesis takes the outdoor spaces as a complex and roots the sectors' graph from the continuous public space.

The sectors' analysis can be criticised for its reductionism. Its oversimplification of the functional structure of a house may mislead the subtleties present in the complex itself. Nonetheless, as Winston (1984) affirms, 'a representation is a set of conventions about how to describe a class of things. A description makes use of conventions of a representation to describe some particular thing' (Winston, 1984: 291). Therefore, by representing house's functional sectors through a set of conventions, it is possible to describe one of its particular dimensions. This research assumes, as Hacking (1983) proposes, that knowledge is generated by defining ways of making underlying regularities or patterns representable and measurable. It is the primacy of the data in revealing such regular phenomena that opens the field for theoretical formulations. Therefore, the sectors' analysis aims at 'creating phenomena' by observing, representing, transforming and calculating the forms by which domestic activities are disposed in the house form. The identification of regularities and anomalies in the data would allow for reasoning on the sectors' nature of Recife modernist dwellings.

Recent studies have used simplified models for generating phenomena. One interesting example of a synthetic form of architectural representation is seen in a recent paper by Van Leusen. The author aims at generating housing typologies, because 'architectural typology is a potentially powerful way of condensing architectural knowledge' (Van Leusen, 1996: 1) and is useful in early stages of design. Van Leusen argues that the arrangement of a few components - rooms, dwellings and corridors - is the first challenge to satisfy the basic housing requirements. These three basic elements and the possible ways of arranging them form the basis of Van Leusen's typologies. The author represents rooms and dwellings as nodes and corridors as edges in a graph.

The combination of these elements is defined by restrictions such as front or back orientation, adjacency - right or left, and number of storeys.

The possible arrangements of these elements are reduced in terms of feasibility and forming a set of basic topological arrangements which is given to the designer as a precedent information. The vagueness of the types allow introducing specific requirements for each particular problem, as well as reviewing previous decisions and restudying the problem from this set of paradigmatic examples. The author concludes that 'it is possible to represent buildings with a sufficient degree of abstraction at high levels of spatial organisation without losing well definedness' (Van Leusen, 1996: 162).

This assumption is also taken by Steadman (1998) in his proposed archetypal form of buildings. The author takes the idea of the biological archetype, as conceived by the pre-Darwinian anatomist Richard Owen, and proposes a similar approach to the built form. Owen observed similarities in the structure of different animals, albeit differences in size, shape, and function. For example, legs and wings are 'homologous', i.e., are similarly positioned in the whole structure; even though they have different formats, they are used for different purposes. To account for these similarities and inequalities, Owen proposed an archetype, a theoretical abstraction of animal structures which could be geometrically deformed or have some of its parts suppressed to represent real cases. Steadman points out that Owen's biological archetype, more than a geometrical device, aimed at explaining the 'design of animals'.

Steadman argues that a similar homology is to be found in buildings. The author establishes two fundamental variables in built form: one concerning lighting, as artificial or daylit; the other, the 'building's interior texture', as cellular spaces, open plan spaces or halls, the latter understood as 'large single spaces for assembly or performances' (Steadman, 1998: 94). These categories, based on a large survey carried out by the author in previous empirical studies on the British building stock, are combined to classify typical built forms, for example, to see if a cellular space is either artificially lit or naturally lit. Day light spaces are also considered to be either lateral or toplit.

A notional and parameterised archetype is sketched, representing all possible combinations of the listed categories (figure 2.7.). The sketch is a grid-like structure, with daylit spaces at the edges, artificially lit spaces at its core, and courtyards. As its biological counterpart, the archetypal building can be continuously deformed or have its parts suppressed in order to represent real cases. The number and size of the courtyards and floors are also notional, as variables like height can be parameterised to multiply layers of floors, or all of them may be suppressed, representing ground-floor buildings. This archetypal building, can be used as an explanatory device, justifying plans' restrictions; it can also be applied in understanding changes in the built form through history; but mostly in generating a catalogue of built form to support the design process.

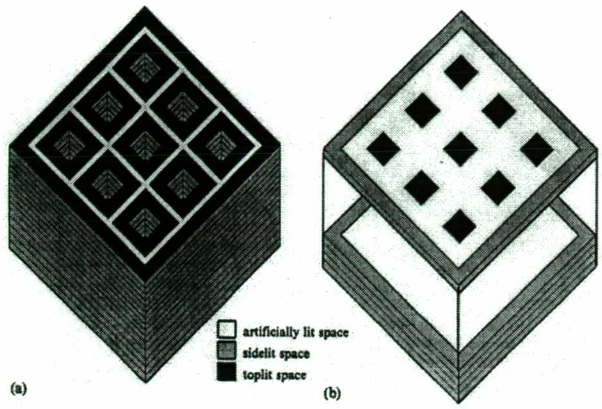


Figure 2.7. Steadman's archetypal building, after Steadman, 1998

Steadman's archetype may be questioned by its reductionism and the arbitrary definition of buildings' categories. Other variables, such as natural ventilation might be more suitable to represent buildings in regions where air-flow is as important as natural lighting. The generality of the archetype itself may be questioned for representing any built form because of its continuous deformation. Obviously, this is the property of an archetype, but one may argue that it might have assumed any other form, rather than the sketched grid-like structure. In spite of these criticisms, Steadman's synthetic representation of buildings is a powerful instrument to capture fundamental patterns of built form, otherwise invisible.

This study has taken a similar approach. It is believed that buildings can be abstractly represented without losing 'well-definedness'. Moreover, it is also believed that representation is the fundamental stage for generating phenomena, therefore allowing the emergence of theories.

2.2.2.2. Measuring

The compact sectors' graph, detailed in the previous section, can be scrutinised according to its configurational properties, i.e., number of nodes, depth, integration and the types of space by which they are composed. The most basic measure is the topological size of the graphs, i.e., the number of nodes by which they are formed. Size indicates complexity, because defines the possible number of combinations of sectors. In simple combinatorial terms, the higher the number of nodes, the more graphs are possible to be composed. On the other hand, if increasing size combinatorial possibilities explode, the chance to identify equal arrangements decreases proportionally.

If graph size sets up the combinatorial meta-field from which the sectors' arrangements are built, syntactic measures count for their configurational properties. One point of interest is depth. Depth indicates the number of steps necessary to move from one node to another. Total depth indicates the total amount of steps from one space to all the others, which can be summarised by its mean value. In this study, depth from the exterior is important to indicate the relative position of the sectors from the public viewpoint, as well as integration, or the relative depth of a sector to the others.

A final account of the graphs is given by the types of space by which they are formed (figure 2.8.). There are, according to Hillier (1996), four topological types of space: a-type space (space 7) has one link; b-type (space 6) has more than one connection and lies on a tree; c-type (spaces 2 to 5) has more than one connection and lies on a ring; and d-type space (spaces 1) has more than two connections and lies at least in two rings. He demonstrates that global properties of systems depend on the local configuration of cells or the types of space found in the systems. For example, segregation is created by b- and c-type spaces, while integration is generated by a- and d-type spaces. In other words, 'segregation in a complex is created almost entirely by the sequencing of spaces' (Hillier, 1996: 321).

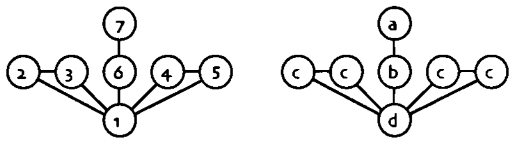


Figure 2.8. Justified graph of a hypothetical building and its space types

Hillier suggests that there is a fundamental relationship between these elementary topologies and the generic types of human behaviour in buildings, which are occupation and movement. Occupation is more suitable for a-type space, where there is no 'through' circulation, while movement is for b- and c-type spaces, where access and egress are highly controlled. The d-type space offers choices, increasing movement. Looking at the sectors' graphs from this viewpoint indicates the role of the sectors, whether to prioritise occupation, or to prioritise movement, or even to generate movement and potential interfaces.

The degree of space-ness of the complexes can indicate to what extent these properties are embedded in the conceptual graphs. The degree of space-ness is calculated according to the following procedures. The degree of a-ness is obtained by dividing the number of a-type spaces by the total number of nodes minus one, because the maximum number of a-type spaces in a complex is found in a shallow bush graph composed by a-type nodes and a single b-type space. The degree of b-ness, is found by dividing the number of b-type spaces by the total number of spaces minus two, because b-type spaces are always a way to another space. The degrees of c-ness and d-ness are calculated by the number of space types over the total number of nodes, as graphs can be composed by c- and d-type spaces, only. The equations assume the following forms,

$$a\text{-}ness = a / n - 1 \qquad [4]$$

$$b\text{-}ness = b / n - 2 \qquad [5]$$

$$c\text{-}ness = c / n \qquad [6]$$

$$d\text{-}ness = d / n \qquad [7]$$

It is expected that the sectors' representational procedure might reveal the more primary and basic formulation of the domestic universe, present at the sectors' level. Moreover, it is expected that this meta-syntactic analysis might capture the prototype, or prototypes, of what a modern house should be, according to Recife's designers.

2.3. The sample

During data gathering, there was a deliberate attempt to collect as many architects' houses as possible. In total fourteen residences of architects were collected and seven houses were selected from the sample for study. They represent different architectural ideologies, including leading figures of the professional and educational milieu, and incorporating seminal dwellings, often cited by critics and historians. The sample is formed by the houses designed by Reynaldo, Borsoi, Esteves, Domingues, Campello, Svenson and Pontual. These houses were designed between 1954 (Reynaldo) and 1975 (Pontual), built in Recife and neighbouring cities. The architects were graduates of Recife (4), Rio de Janeiro (2) and Belo Horizonte (1). The houses were designed from scratch, without any restraints, unless the ones determined by the urban context, building regulations and owners' desires. This set is complemented by the house designed by Amorim to be built in Oporto, Portugal. Notwithstanding its separation from Recife's social and cultural ambience, Amorim's house was included since it sums up his views on the modernist domestic organisation, which were fundamental in the education of generations of Recife's architects (Bruand, 1981; Silva, 1994).

2.4. House-by-house analysis

The analysis is developed in three steps. Firstly, a brief presentation of the architect is made, being followed by a description of the house. Next, syntactic data is presented. The houses are compared and results discussed in section 2.5. The summary of the analysis is presented in tables 2.1 and 2.2., and the illustrations and analytical graphs are presented along with the description of each house. For a detailed view on the numerical results of the analysis, see appendix A2. Tables A.2.1. to A.2.6. presents the rank order of integration and visual integration of the houses, and tables A.2.7. to A.2.14., present the syntactic data organised house-by-house.

Table 2.1. Recife architects' houses: geometrical and syntactic data

House		Area			Convex (C)					Bounded (B)			B:C		Space use		Space-link		
	Date	st	plot	house	t	b	ed	o	o:b+e	t	b	ed	b	b+ed	f	t	DF	all	house
Amorim	1947	3	•	492.67	37	33	0	4	0.24	7	7	0	0.212	0.212	24	9	0.73	1.262	1.061
Reynaldo	1954	mez	450.00	171.50	33	20	2	11	0.50	5	3	2	0.150	0.227	12	8	0.60	1.265	1.100
Borsoi	1955	2	525.70	306.60	42	22	5	15	0.56	11	6	5	0.273	0.407	16	6	0.73	1.326	1.091
Esteves	1959	2	363.20	191.80	28	16	3	9	0.47	11	8	3	0.500	0.579	11	5	0.69	1.138	1.000
Domingues	1963	bas	483.30	315.65	41	19	3	19	0.86	11	8	3	0.421	0.500	14	5	0.74	1.238	1.000
Campello	1967	1	624.00	204.00	33	15	5	13	0.74	8	3	5	0.200	0.400	10	4	0.71	1.265	1.071
Svenson	1969	1	360.00	154.30	20	12	0	8	0.67	4	4	0	0.333	0.333	9	3	0.75	1.429	1.167
Pontual	1975	2	900.00	420.00	48	23	3	22	0.88	10	7	3	0.304	0.385	15	8	0.65	1.260	1.000
Mean			529.46	251.98	35	18.14	3	13.86	0.62	8.57	5.57	3.00	0.312	0.405	12.43	5.57	0.70	1.273	1.061

st=storeys, t=total, b=building, e=edícula, o=outside, f=function, t=transition, DF=degree of functionality.

Table 2.2. Recife architects' houses: syntactic data

Houses	**Integration - RRA (inside)**					**Integration - RRA (whole complex)**					**Integration Core**	
	min	mean	max	BDF	DV	min	mean	max	BDF	DV	spaces	%
Amorim	2.907	1.672	0.918	0.751	1.09	2.867	1.566	0.912	0.746	1.10	7	17.07
Reynaldo	2.670	1.673	0.987	0.812	0.95	2.126	1.255	0.878	0.837	0.88	6	18.18
Borsoi	2.756	1.887	1.244	0.876	0.77	2.587	1.460	0.873	0.770	1.05	7	16.67
Esteves	2.049	1.323	0.683	0.782	1.01	2.080	1.537	0.918	0.874	0.77	5	17.86
Domingues	2.971	1.844	1.132	0.820	0.93	1.881	1.261	0.846	0.874	0.78	7	17.07
Campello	1.730	1.194	0.625	0.812	0.93	1.845	1.279	0.754	0.850	0.84	6	18.18
Svenson	1.596	1.042	0.383	0.673	1.20	1.462	0.884	0.432	0.736	1.11	3	15.00
Pontual	2.854	1.926	1.075	0.824	0.91	2.877	1.559	1.062	0.791	0.99	11	22.45
Mean	*2.441*	*1.570*	*0.881*	*0.794*	*0.96*	*2.216*	*1.350*	*0.834*	*0.810*	*0.94*	*6.50*	*17.81*
Houses	**Visual RRA (inside)**					**Visual RRA (whole complex)**					**Cognition**	
	min	mean	max	BDF	DV	min	mean	max	BDF	DV	all	building
Amorim	0.836	0.462	0.165	0.584	1.38	0.394	0.242	0.082	0.618	1.30	0.109	0.577
Reynaldo	1.065	0.579	0.260	0.655	1.27	0.551	0.272	0.068	0.399	1.63	0.117	0.693
Borsoi	1.111	0.521	0.244	0.588	1.39	0.508	0.288	0.151	0.729	1.13	0.532	0.746
Esteves	0.569	0.365	0.076	0.475	1.46	0.560	0.352	0.187	0.780	1.02	0.122	0.502
Domingues	0.679	0.340	0.113	0.505	1.50	0.608	0.269	0.115	0.520	1.49	0.555	0.493
Campello	0.817	0.597	0.144	0.575	1.30	0.608	0.291	0.101	0.495	1.52	0.446	0.536
Svenson	0.574	0.351	0.000		1.86	0.408	0.247	0.000		1.87	0.309	0.374
Pontual	1.220	0.721	0.372	0.744	1.10	0.523	0.266	0.070	0.435	1.58	0.174	0.779
Mean	*0.859*	*0.492*	*0.172*	*0.589*	*1.35*	*0.520*	*0.278*	*0.097*	*0.568*	*1.42*	*0.296*	*0.588*

2.4.1. Delfim Amorim House - 1947

Delfim Amorim (1917-1972) studied at the *Escola de Belas Artes do Porto*, where he worked briefly as an assistant. He was one of the leading figures in the renovation of modern architecture in Portugal (Barbosa, 1972). One of the key issues in the Portuguese modern movement was the conflict between tradition and modernity, instigated by the Salazarist government which proclaimed the existence of a traditional Portuguese architecture and disdained the modernist expression as ideologically biased (Vicente, 1976). Brazilian modern architecture, publicised by books like *Brazil Builds* (Goodwin, 1943), presented Portuguese modern architects with an answer to this paradox between tradition and modernity, exemplifying how cultural values could shape the international style to the distinctive demands of their countries, without being traditionalists or reactionary (Portas, 1978; Fernandez, 1988; Ferrão, 1993). This key idea of allying modernism with cultural tradition remained deeply embedded in his work. Amorim moved to Recife in 1951, where he developed hugely successful career as a professor and practitioner (Silva, Amorim et al., 1981; Amorim, 1989b; Silva, 1994).

Amorim dealt with the problem of the architects' house in his Diploma dissertation in 1949 (Amorim, 1987; Costa, 1987; Mendes, 1987). The architect submitted two solutions for the same problem, trying to prove that independently of the 'material at architect's disposal, he can produce a contemporary architecture' if he applies the 'technical knowledge acquired from the constant contribution of the scientific spirit' and interprets and satisfies 'the social problems of his time, which means, intellectual, spiritual and physical needs of men' (Amorim, 1987: 14). One proposal uses traditional materials and techniques, and the other applies an independent concrete structure, free plan, pre-fabricated elements and rationalist aesthetics (figure 2.9.). The available material concerning the projects is limited.[14] The location, the plot's characteristics, and floor plans are incomplete in the published material. For example, the first floor of the 'traditional version' is missing, invalidating any syntactic analysis. For this reason, the analysis is centred in the 'contemporary version'.

The house is an essay on Le Corbusier's five points: the pilotis, the free plan, the free façade, the horizontal window and the roof garden (Corbusier and Jeanneret, 1970). The recessed ground floor is accessed by a formal entry, which leads to the architects' office and social area. The free plan is extensively explored by isolating glass walls and partitions from the 3 by 4 structural grid. In the open ground floor plan, domestic activities are convexialy articulated keeping the flow of space continuos. The kitchen and the servants' compartments, on the other hand, are recessed and enclosed.

14 Unsuccessfull efforts were made beside the *Faculdade de Arquitetura da Universidade do Porto* to obtain a complete set of their plans.

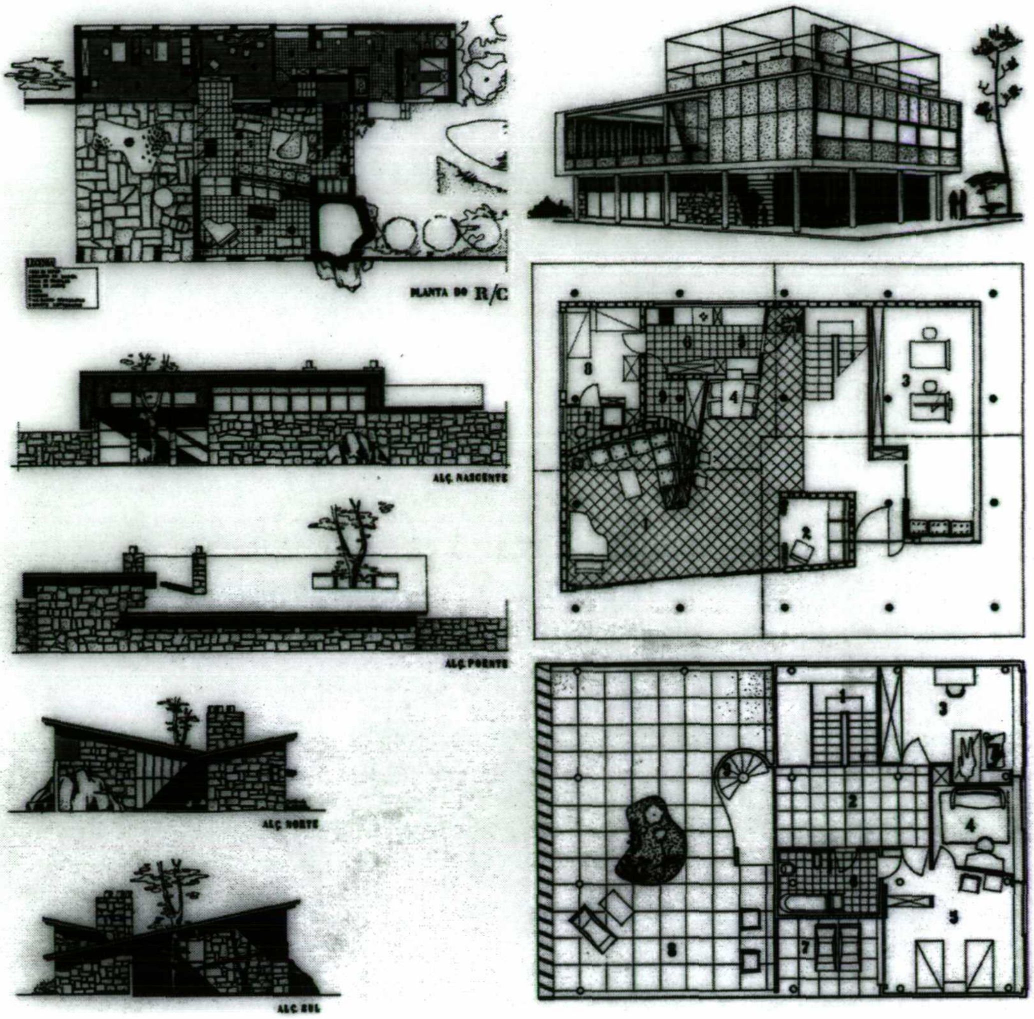


Figure 2.9. Amorim houses: 'traditional' and 'contemporary' versions, 1947, after Amorim, 1987

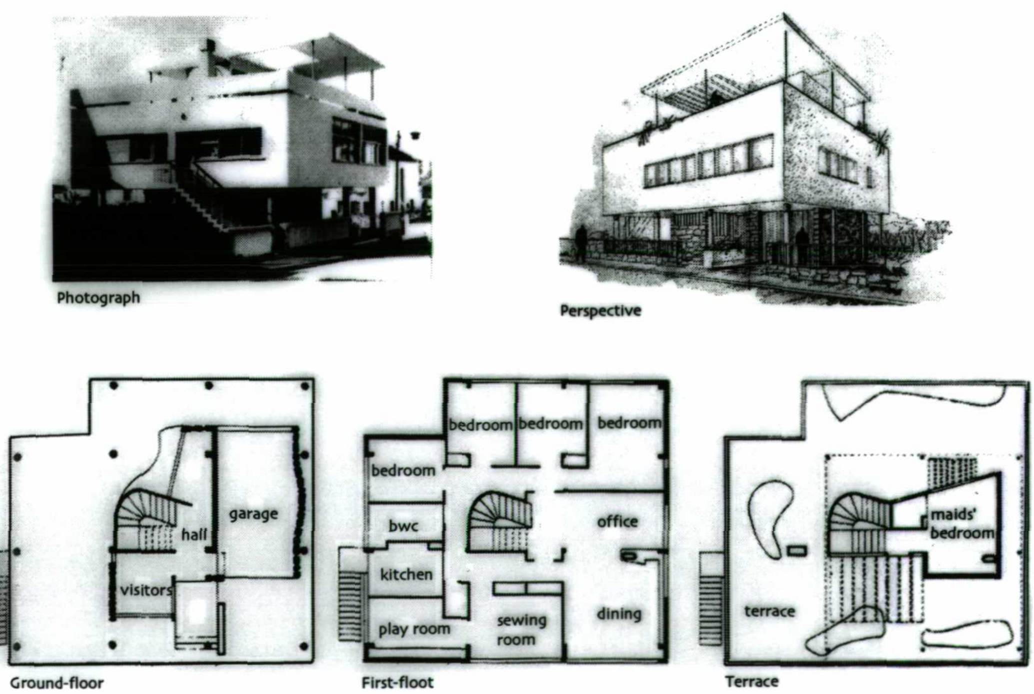


Figure 2.10. Rocha House, by Amorim and Martins, Guimarães, 1947, after Silva, Amorim, et all, 1981

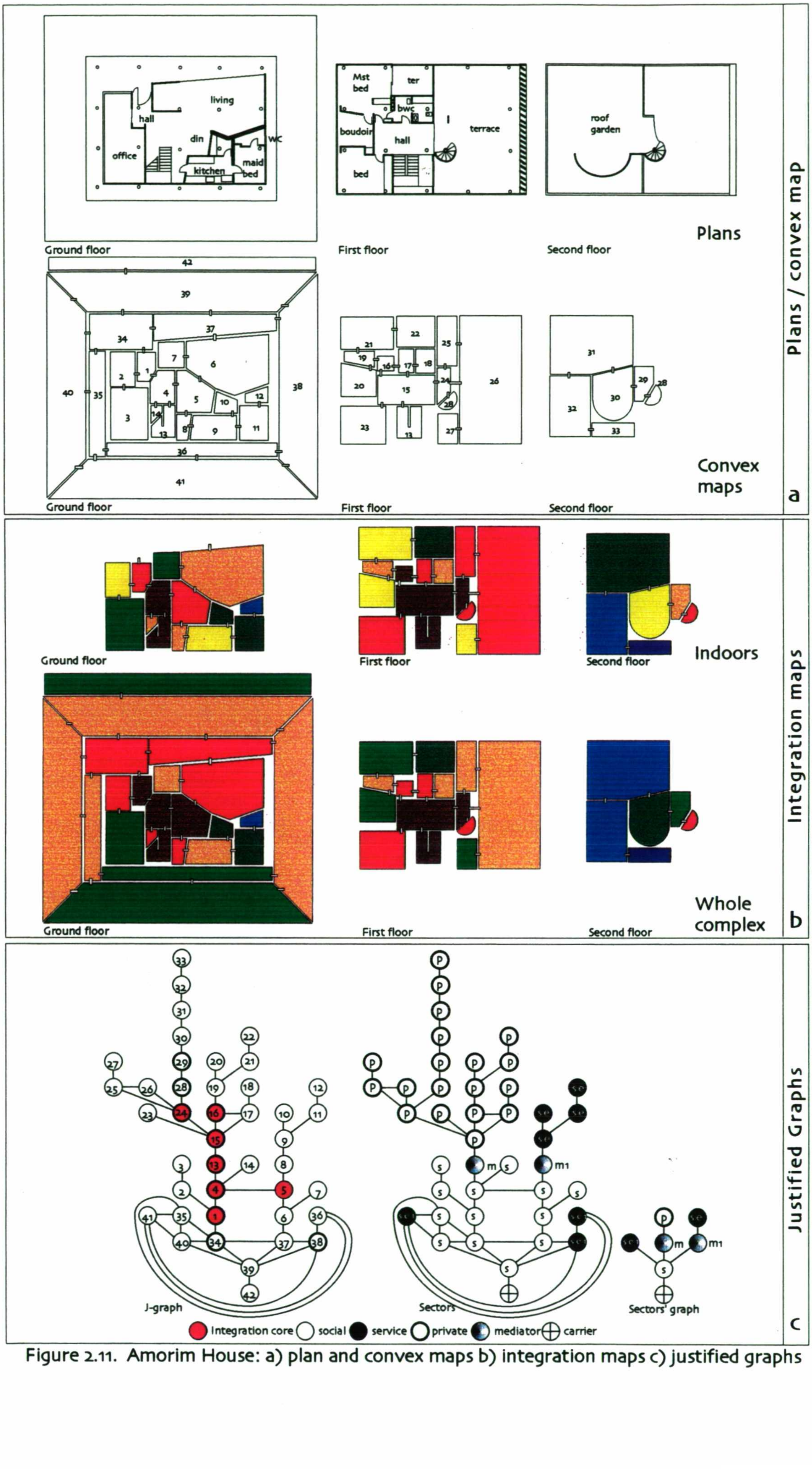
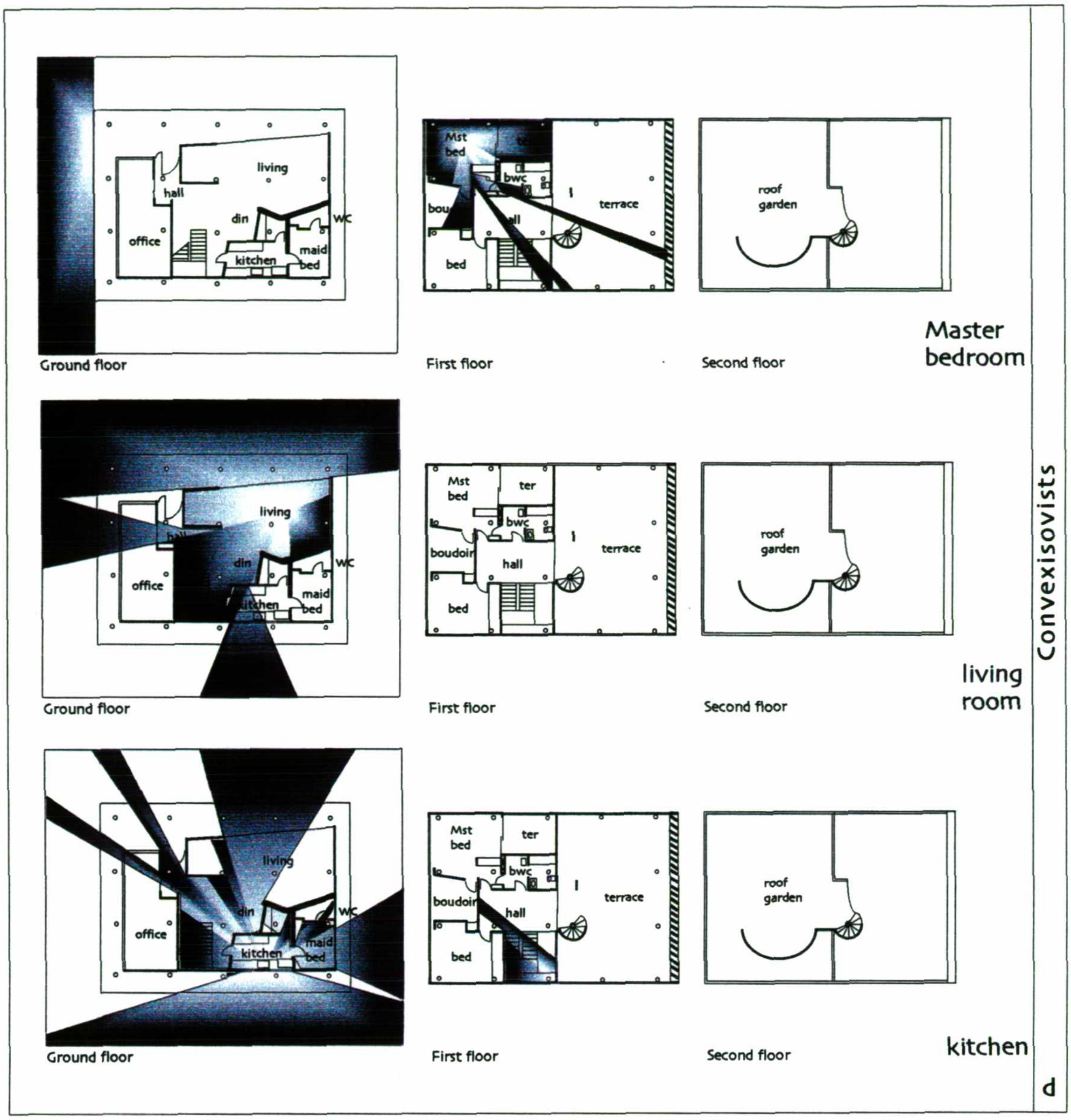


Figure 2.11. Amorim House: a) plan and convex maps b) integration maps c) justified graphs



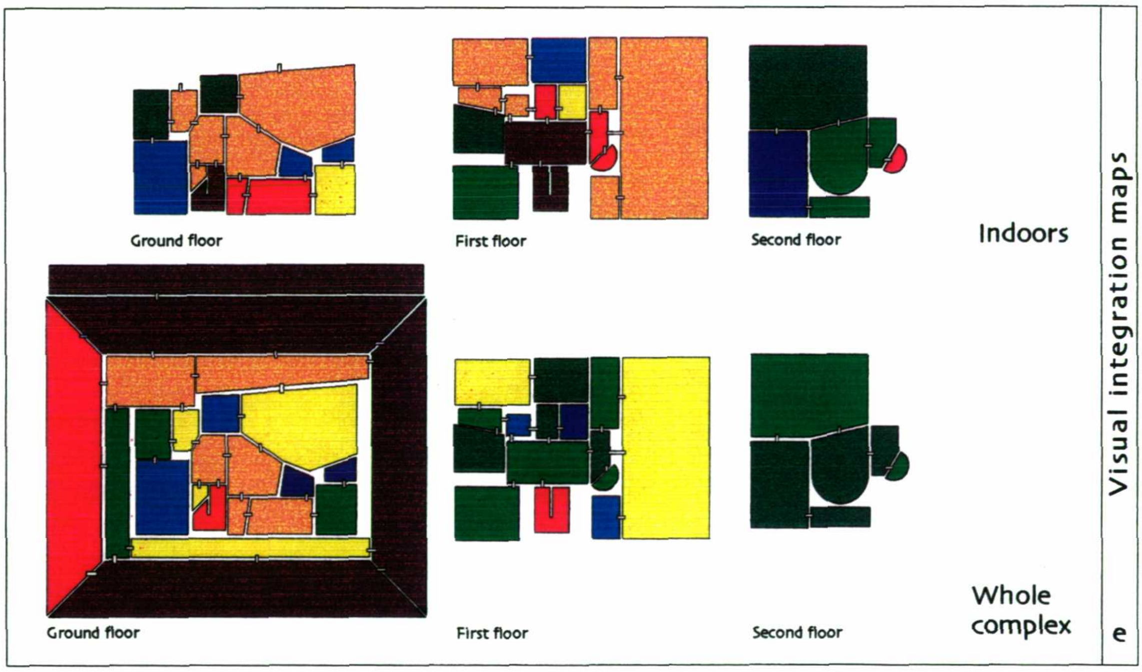


Figure 2.11. Amorim House: d) convex isovists e) visual integration maps

The first floor, accessed by an open staircase, is occupied by the bedrooms, toilet, and a roof garden. As in Corbusier's Villa Savoye, the open terrace gives access to the roof top, which is encapsulated by an iron frame, continuing the spatial module used in the floors below. This architectural essay was later redesigned, with Oliveira Martins, and built in Guimarães, Portugal[15] (Silva, Amorim et al., 1981: pp 68-69; Fernandez, 1988: 83) (figure 2.10.). Unlike his own house, the plan is very conservative, perhaps constricted by client's desires. However compartmentalised the main floor is, the independent structure is held exposed.

Figure 2.11. presents the plans, convex integration and visual integration maps (coloured from deep red - high integration to deep blue - high segregation), and the justified graphs of Amorim House. The j-graphs show that domestic activities are clearly categorised and grouped into sectors. The social sector is situated in the ground floor, controlling the access to the other zones of the house, further isolated by buffer spaces. Interior and exterior service spaces are isolated from each other, an aspect not to be seen in the following houses. The tree-like sectors' graph, shows the central position of the social sector and the overall isolation of the service and private ones.

Amorim House is the most segregated house in the sample, with a mean value of 1.566, but second in the base difference factor (BDF), 0.746. It is transition centred, having the social vestibule and the main staircase, which mediates the passage from the social area to the private zone, as the most integrated spaces. The outside spaces for social reception and entertaining, situated at the front of the house, are the most integrated outdoor spaces (figure 2.11.b).

The house itself is very tree-like, with only two local rings in the first floor: one gives access to the bathroom either from the circulation or from the master bedroom; the other, allows a twofold link to the roof terrace. Connections to the outside introduce a single ring to house's interior, crossing the main living areas and the reception. This ring is important, offering a more informal approach to the house through the living room sliding doors.

The formal entry also gives access to the office compound, situated at a shallow position. In Hanson's terms, Amorim's office is a 'concierge model': shallow from the street, segregating work from the family life (Hanson, 1997). According to Hanson, this type can also be included in a shallow ring, allowing entrance from the outside and a direct connection to the interior of

15 Amorim used Vila Savoye as a reference for another house, Alfredo Lages House, in 1954, in Recife, but without using roof-gardens, for climatic reasons (Silva, Amorim et al., 1981: pp 74-75).

the house, giving more privacy for the family. The 'concierge model' contrasts to the 'eyrie model': deep from the street and extremely segregated. In this more introverted model, the working area is positioned to ensure status among the members of the family (Hanson, 1997). In single storey houses they tend to occupy the most segregated positions.

Its integration core, composed of 25% of integration of the house, is formed by seven spaces, being relatively shallow from the street (figure 2.11.c). The core is essentially interior, including the vestibule and dining room, the staircase and the first floor hall, and the access to the main bedroom. The living room follows the order of integration, confirming the privileged position of the entertaining area in the complex.

The staircase's void reduces the strong horizontality of the layout, allowing, even if limited, the generation of visual links between the floors (figure 2.11.d.). Otherwise, the visual fields of the interior spaces are very much restricted to each floor, unless outside spaces are counted. The relative segregation of the kitchen is contrasted by its significant visual field which dominates the entry and dining room, but, curiously, does not invade both secluded receiving areas. The isovist of the main living space dominates the front gardens, and spreads indoors through the social spaces and the kitchen. The main bedroom is quite secluded, visually, getting glimpses of the hall and staircase.

The visual nature of the house is better measured by the visual integration, or the relative visual distance from each space to all others (figure 2.11.e.). The house is the most visually integrated house of the sample, with the outside spaces (0.242), but not as so without them (0.462). The gardens and the exterior are the most visually integrated spaces. This is because, even asymmetrically, they account for the spaces in the top floors. Indoors, the staircase is positioned at the visual core, dominating both floors. The kitchen is more integrated than both receiving areas, being amongst the 'warmest' ground floor rooms. The main bedroom, detached from the 'cold' first floor and the terrace are the most visually integrated spaces of the top floors.

The degree of cognition of the whole complex is very weak (0.109), whereas within the building itself it is higher (0.577), although not very strong (figure 2.12.). This result shows numerically what could be deduced from the observation of the plans themselves. The isolation between floors and the visual asymmetry generated by the roof terraces, makes the system work in parallel ways. This is a house which must be peripatetically understood.

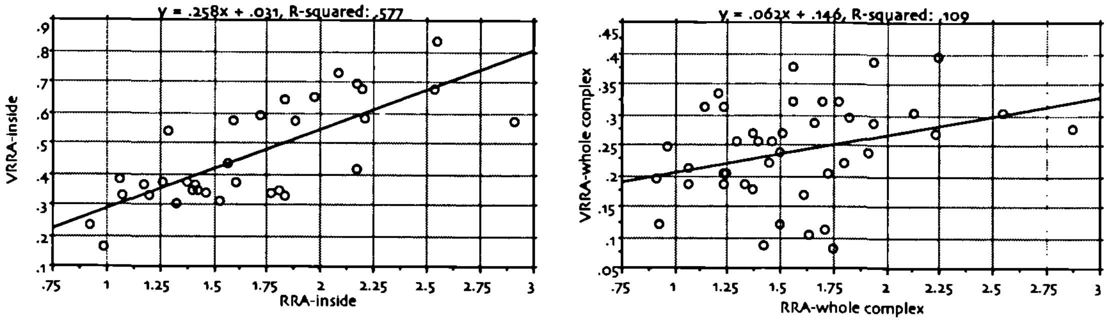


Figure 2.12. Amorim House: cognitive value

In conclusion, Amorim house is an architectural statement against the establishment, and for this reason expresses 'modernity' in its extremes. It is a house spatially elaborated in its forms, but configurationally weak, however expressing with objectivity the architect's intention in establishing sectors' isolation, mostly by means of buffer spaces and levels. Nevertheless, the expressive position of the kitchen and the main bedroom, perhaps denounces architect's view of women's position in the household; dominant, but in the background.

2.4.2. Augusto Reynaldo House - 1954

Augusto Reynaldo (1924-1958) had a short but significant career as architect and painter (Ferreira, 1958; Lima, 1958; Lima, 1985). Before opening his office, he worked as a draftsman and assistant to Heitor Maia Filho, founder and lecturer of the *Escola de Belas Artes do Recife*. One of his most regarded contributions to architecture is the creation of the *peitoril ventilado* - aired parapet (Holanda, 1976: 25), an ingenious solution to allow the air flow while keeping the windows closed (figure 2.13.). [16]

His house is situated at a corner site of a middle class neighbourhood, facing the main Westwards route off Recife. The house is a rectangular building with a trapezoidal profile. It is relatively small (165.00 m^2), but deceptively impressive in appearance, because of the composition of a massive white volume resting on a slightly recessed ground floor mass (figure 2.14.). Its program is distributed in a single floor and a mezzanine, in a straight-forward plan: the social area faces Caxangá Avenue, the aligned bedrooms face the secondary street, and the service areas are secluded at the back of the plot.

This solution is reflected in its sectors' graph (figure 2.15.c). The ringiness of Reynaldo House diagram contrasts with the previous house. Double entrance, and direct access between the service and private sectors, and between the

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[16] The patternity of the aired parapet has been constested by others, who point Amorim as its designer (Silva, 1994: 77; Ayrton Carvalho, 1981, pers. comm)

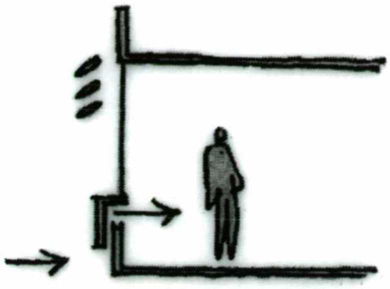


Figure 2.13. Peitoril ventilado, by Reynaldo, after Holanda, 1976

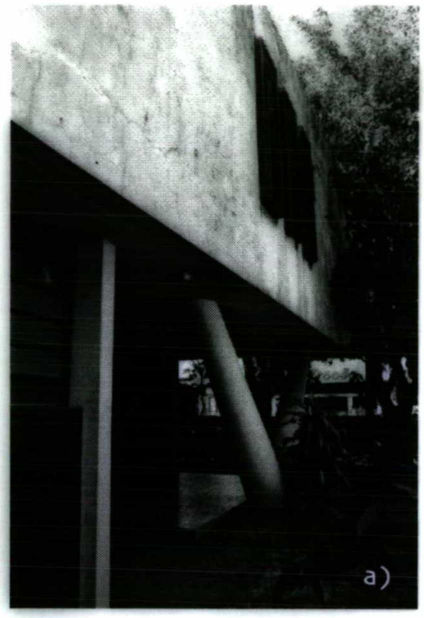


Figure 2.14. Reynaldo House, a) terrace, b) main volume

Figure 2.15. Reynaldo House: a) plan and convex maps b) integration maps c) justified graphs

Figure 2.15. Reynaldo House: d) convex isovists e) visual integration maps

social and service sectors, creates new forms of interaction, not offered by Amorim House. If one house is controlled, the other is more informal, as the space-to-space permeability confirms. There is a single local indoor ring connecting the master-bedroom, corridor and children's bedroom, allowing for a better surveillance by the parents. Important rings are added with the outdoors, generating alternative accesses to the house either through the garage to the service and private area (a very unusual solution), and through the living room and kitchen.

The mean integration of the house is 1.255, being relatively highly differentiated, with a basic difference factor of 0.836. The house is transitionally centred at the mediator space, followed by its adjacent spaces, the dining room and kitchen's hall and the living room (figure 2.15.b). This mediator-social-service sequence indicates the prevalence of social/front activities against service/back activities. However, the outdoor spaces show a reversed order. The laundry is the most integrated outside space, followed by the terrace. These indoor and outdoor spaces form the integration core of the house, which forms a diagonal from the social to the service sector. The highly integrated service spaces seems to be an effect of the alternative access offered by the garage, bringing service spaces more shallowly to the rest of the house.

The architects' office is situated on the mezzanine floor, overlooking the dining room. Its location does not fall into any of Hanson's types. Although being extremely segregated (1.775) the office is shallow from the receiving area and its visual connectivity overcomes its relative isolation. This type of office is neither professional nor personal, but it falls in-between the two. Its degree of privacy gives the necessary isolation for intellectual activities, but its proximity to the social area gives the architect the chance to transform it in a male entertaining room, using a social event to introduce visitors to his latest projects. This type of office should be called the 'receiving model', because integrates work with family life.

The transparency found in the social sector is carefully avoided within the remaining sectors and amongst the sectors themselves. Partitions are used to hide the service and private sectors from visitors' gaze. The isovists of the living, kitchen and main bedroom show the conscious intent to avoid visual contact amongst them (figure 2.15.d.). This results in one of the lowest mean visual integration values for the building itself (0.579), which, curiously, is reversed when the outside is included (0.272). In spite of the seclusion of its main spaces, the outdoors acts to integrate the whole system. The mediator space (space 9) is the core of indoors visual integration, whereas the dining room dominates the social area and mezzanine.

Accessibility and visibility are hierarchically disposed inside the building, so that the more integrated a space is, the more visually accessible it would be. The level of cognition of the system is positive and strong (0.693), but very weak when the outside is included (0.117) (figure 2.16.). This indicates how indoor and outdoor complexes, when concomitantly seen, form divergent realms. In other words, the visual domain of the surrounding spaces and the relative depths of house's spaces are unrelated. This does not necessarily mean that the building is good or bad. It simply indicates that the knowledge of the whole complex from its parts becomes weak. To achieve such understanding one should move about, and not stay stand. Therefore, this is a house axially oriented, and not convexialy oriented.

As in Amorim House, Reynaldo House establishes a spatial contour around the sectors, maintaining their visual and permeable properties constant. The status of the social sector is perceived in the architect's investment in its formal and spatial composition, whereas service and private rooms are unimportant. Despite their formal inequalities, the overall integration pattern works to impose hierarchy in the system, a hierarchy balanced by the strategic link between the very core of the private sector and the service area.

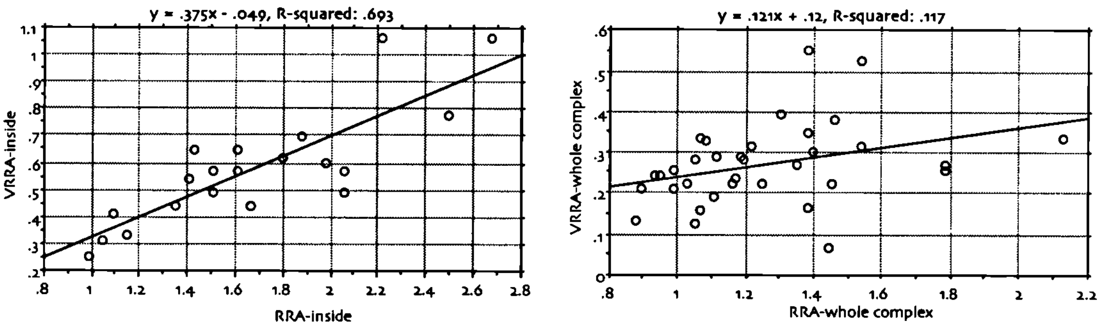
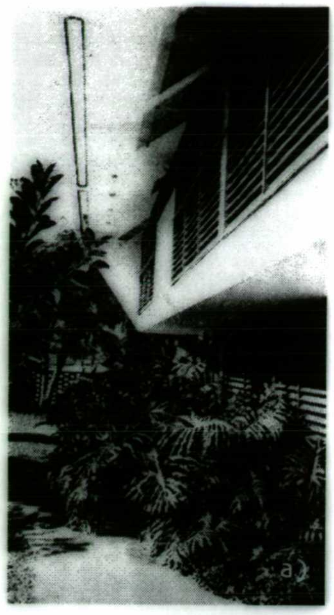


Figure 2.16. Reynaldo House: cognitive value

2.4.3. Acácio Gil Borsoi House - 1955

Acácio Gil Borsoi (1924-) and Amorim were responsible for the renovation of Northeast Brazil architecture in the 1950's, as credited by historians and critics of architecture (Bruand, 1981; Acayaba and Ficher, 1982; Segawa, 1988; Silva, 1988; Wolf, 1989b), but mostly by their students and colleagues (Wolf, 1988; Wolf, 1989a; Wolf, 1989b; Wolf, 1989c; Wolf, 1990). According to Bruand, 'It is due to Amorim and Borsoi, both professors at the Faculdade de Arquitetura, that not only an architectural renewal occurred in Pernambuco, but also the formation of a generation of dynamic young



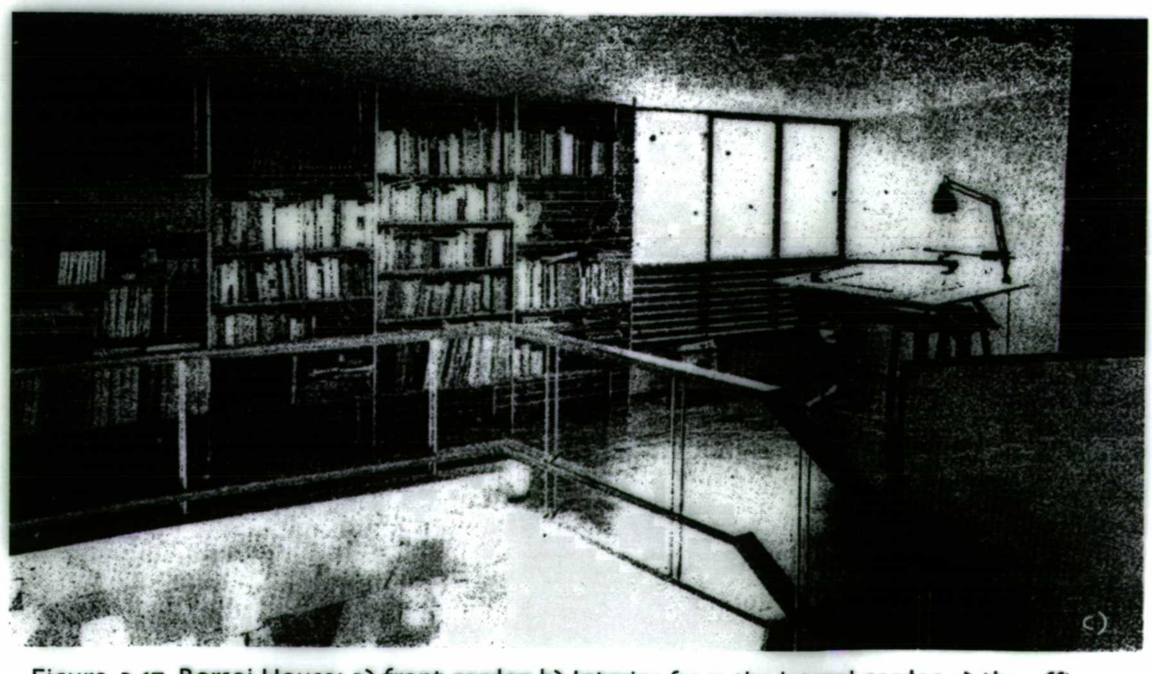


Figure 2.17. Borsoi House: a) front garden b) Interior from the lateral garden c) the office, after Brito, 1961

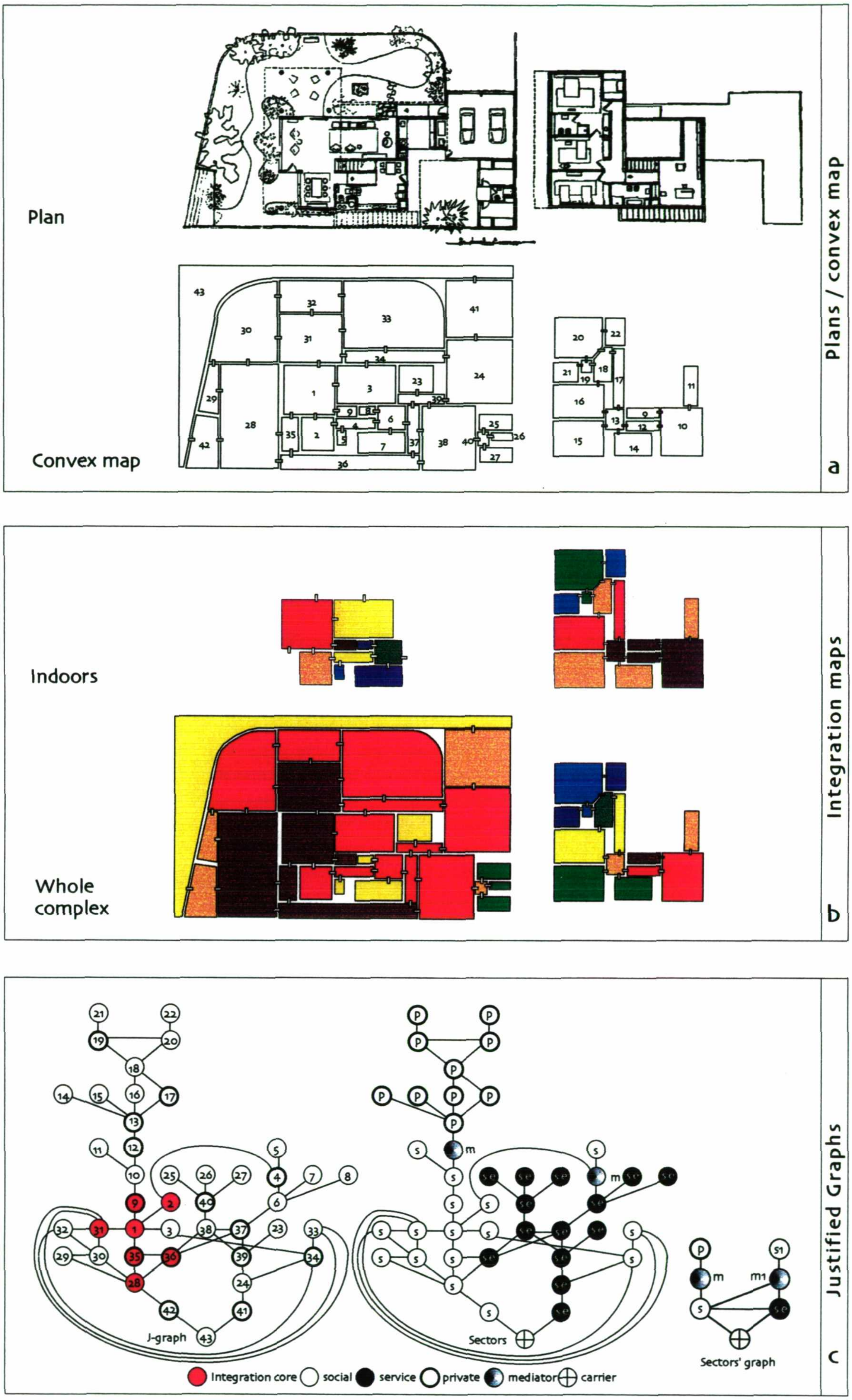


Figure 2.18. Borsoi House: a) plan and convex maps b) integration maps c) justified graphs

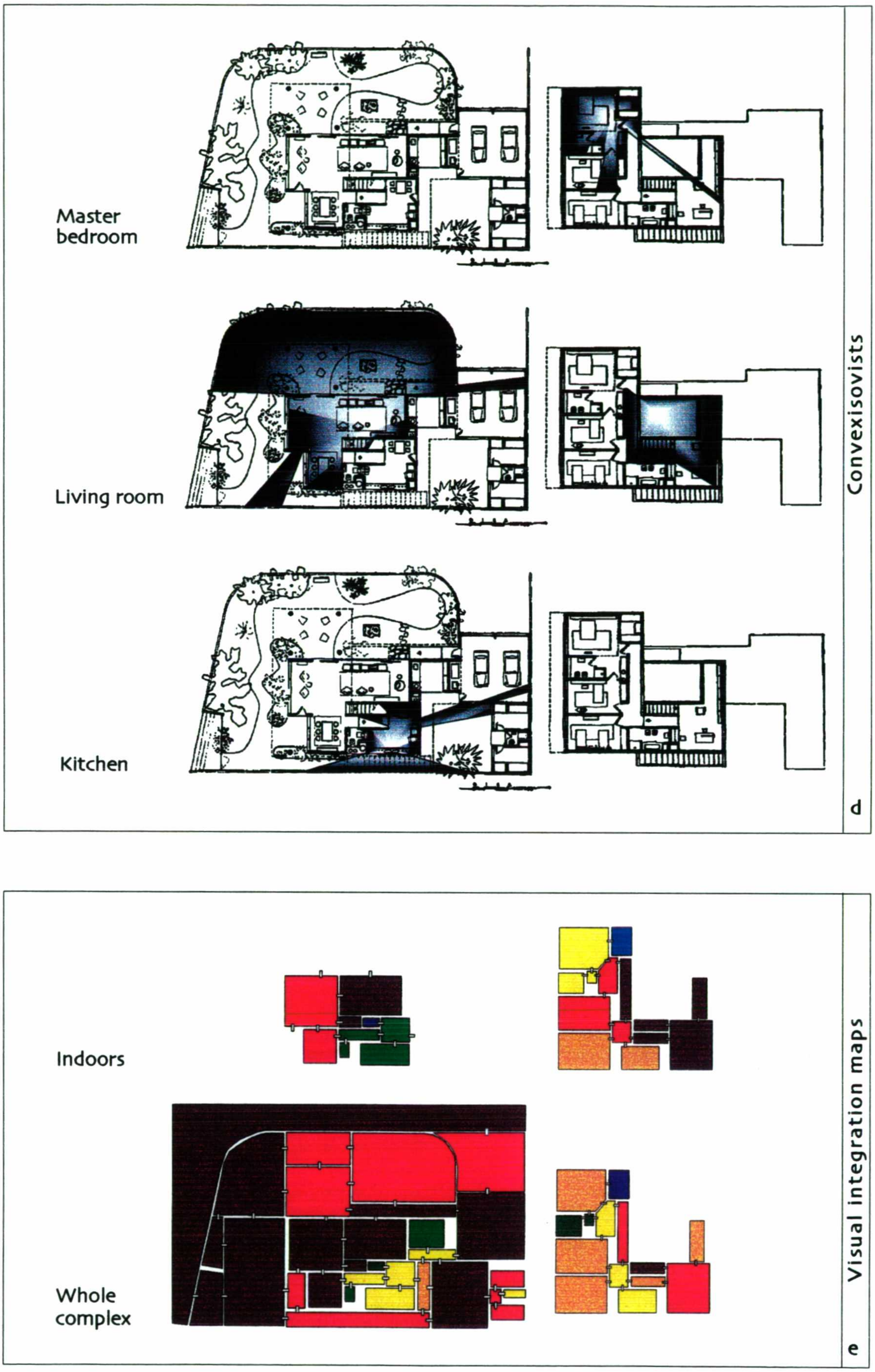


Figure 2.18. Borsoi House: d) convex isovists e) visual integration maps

architects' (Bruand, 1981, pp 148). They both arrived in Recife in 1951, and for a short period worked in the same office, developing a few projects in association.

Borsoi graduated of the *Faculdade Nacional de Arquitetura*, in Rio de Janeiro in 1949, hence the influence of carioca's architecture in his early years (Borsoi, 1996). His work soon acquired personality,[17] characterised by the intense investigation of constructive processes, from the structure to the architectural details, dialogue with the environment, and by the concept that architect's ultimate work is of 'historical and cultural significance' (Borsoi, 1984: pp 2-3). Borsoi's work is known by the constant renewal of his technical and formal vocabularies, being difficult to encapsulate him under any label or strict movement.

Borsoi has built three houses for himself: one in Recife (Brito, 1961), in 1955 (figure 2.17); a renovation of a colonial house in Olinda, in the 1970's; and his late house, built in Rio in 1989 (Browne, Petrina et al., 1994: pp 40-45). This study is focused on his first house, designed for his family of three children, in a corner site at Boa Viagem neighbour (figure 2.18.a.). In this building, social and service entrances are separated, both recessed from the pavement. The visitors' access is carefully orchestrated. After crossing the garden, the visitor approaches a porch from which he accesses the main living areas. In this passage, the house's interior is concealed by extensive venetian blinds, in order to expose the volatile core of the house at once. Interior and exterior spaces flow through wide sliding glass doors, opened to the side garden, and through a central void which connects the three levels of the house. The ground floor houses the main daily activities, but the architect's studio stands overlooking the internal void at an intermediate level, from which the top floor is reached through a typical modernist ramp.

Domestic activities are well defined, as in the previous houses. The individuality of this house is the use of two mediator spaces, isolating internally, the social sector from the service and private ones as seen in figure 2.18.c. Another singularity is the seclusion of the social bathroom from the main social areas. This space appears as a secondary sector in the graph.

The justified graphs of the house shows the existence of two internal rings. The main one is in the private area, amongst the main-bedroom, corridor and children's bedroom. The second ring, in the master bedroom, is a 'trivial ring'[18]

[17] According to the architect, he started to free from his earlier influences by the end of the 1950s, in Luna and Pena houses, built in Fortaleza (Borsoi, 1996, pers. comm.).

[18] A trivial ring is formed by two or three adjacent spaces.

(Hanson, 1998: 278). The outside introduces two main rings to the house, one amongst the receiving spaces and the other includes these very spaces and the kitchen and garage at the back.

Integration seems to reinforce Borsoi's spatial manoeuvres. Integration is centred in the living room and smoothly distributed in the ground floor (figure 2.18.b.) Although its mean integration is not very high 1.460 (amongst the least integrated in the sample), the house presents one of the highest BDF, 0.769. The integration core of the house takes the visitor from the main gate and leads him to the hall, from where the living room is accessed. From it, access is franked either to the terrace or up through the staircase to the office. As in Reynaldo House, Borsoi's office is a 'receiving model'; however, the architect's spatial intuition put it at the centre of integration of the house, both visually and permeably. His professional success is commonly associated with his abilities in public relations. It is possible that spatial configuration may have been intuitively used to integrate and enhance his social and professional status. Outdoor spaces are also configured in order to support social entertaining by highly integrating the terrace. This 'social core' is balanced by the quintal forming the focus of the service activities. Private spaces, secluded on the first floor, are at the lowest band of the order of integration.

The segregation between the sectors is also expressed visually. For example, the kitchen is perfectly secluded from the social area, however the *copa* (informal dining room) is seen from the dining room. The living room have large isovists covering the entire social area and glimpsing the private sector (figure 2.18.d.). The main bedroom is perfectly secluded from the rest of the house. Its visual field is local; however, the void and the framed parapet disclosure parts of the office, one level below.

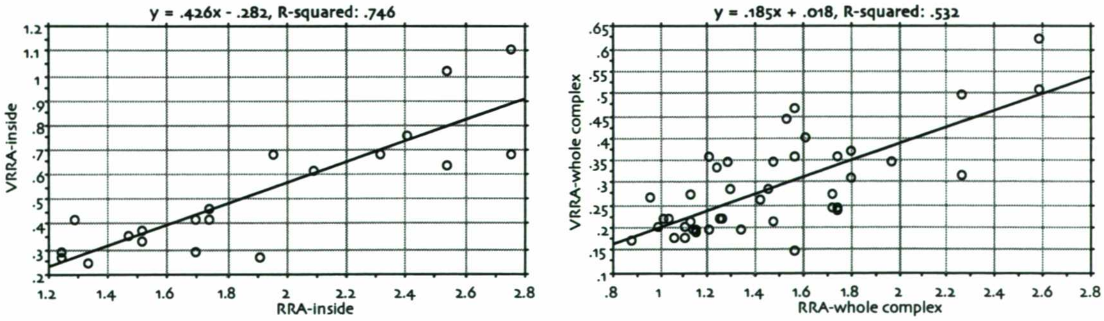


Figure 2.19. Borsoi House: cognitive value

The visual integration analysis maps these inequalities, as well as confirms the very spatial core of the house, around the living areas (figure 2.18.e.). Visibility and accessibility are strongly correlated inside the house (0.746r^2), but also inside and outside as a whole ($0.532r^2$) (figure 2.19.). Keeping high levels of cognition with and within the outside complex confirms Borsoi's domain of the spatial nature of architecture.

In summary, the house combines elaborated formal and spatial compositions. The different sectors of the house are spatially segregated from each other; however, the process by which the parts are linked reinforces the most expressive spaces of the house, integrating formal and spatial composition in a magnificent way.

2.4.4. Reginaldo Esteves House - 1959

Reginaldo Esteves (1930) concluded his studies in 1954, and his projects soon drew the attention of architects and critics, such as Bruand, who highlighted his name amongst the most prominent Recife modern architects (Bruand, 1981: 148). Esteves' architecture evolved from the Brazilian functionalism of the Carioca School, to the fusion between tradition and modernity, mostly in the 1960's, and later embraced the concrete, in its techniques and aesthetic expressions, as the centre of his investigations.

His house, built in 1959, corresponds to his second phase (figure 2.20). The small plot (363.20 m^2), at the Monteiro suburb, might have induced its *parti*: a compact symmetric two storey block, located at the centre of the site. The orientation of the plot, westwards, defined the disposition of the main rooms facing inwards (East). Social and service sectors are accessed through parallel entrances and only connected through the kitchen (figure 2.21.a.).

The sector's graph shows the same need to seclude the social bathroom identified in Borsoi House (figure 2.21.c.). The diagram has a single ring which includes the exterior, the mediator, the social and service sectors, resulting from the separation between the social and service outside spaces. This unusual separation is clearly expressed by the space-to-space configuration of the house (figure 2.21.b.). Centrality is the name of the house. The mediator-transitional core, composed by the corridor and the stairs, form the heart of integration. These spaces are followed by the kitchen, the link between all the service areas and the rest of the house, the dining room and the first floor landing, forming a deep integration core. The mean RRA is one of the highest in the sample, 1.537, as well as its BDF, 0.874.

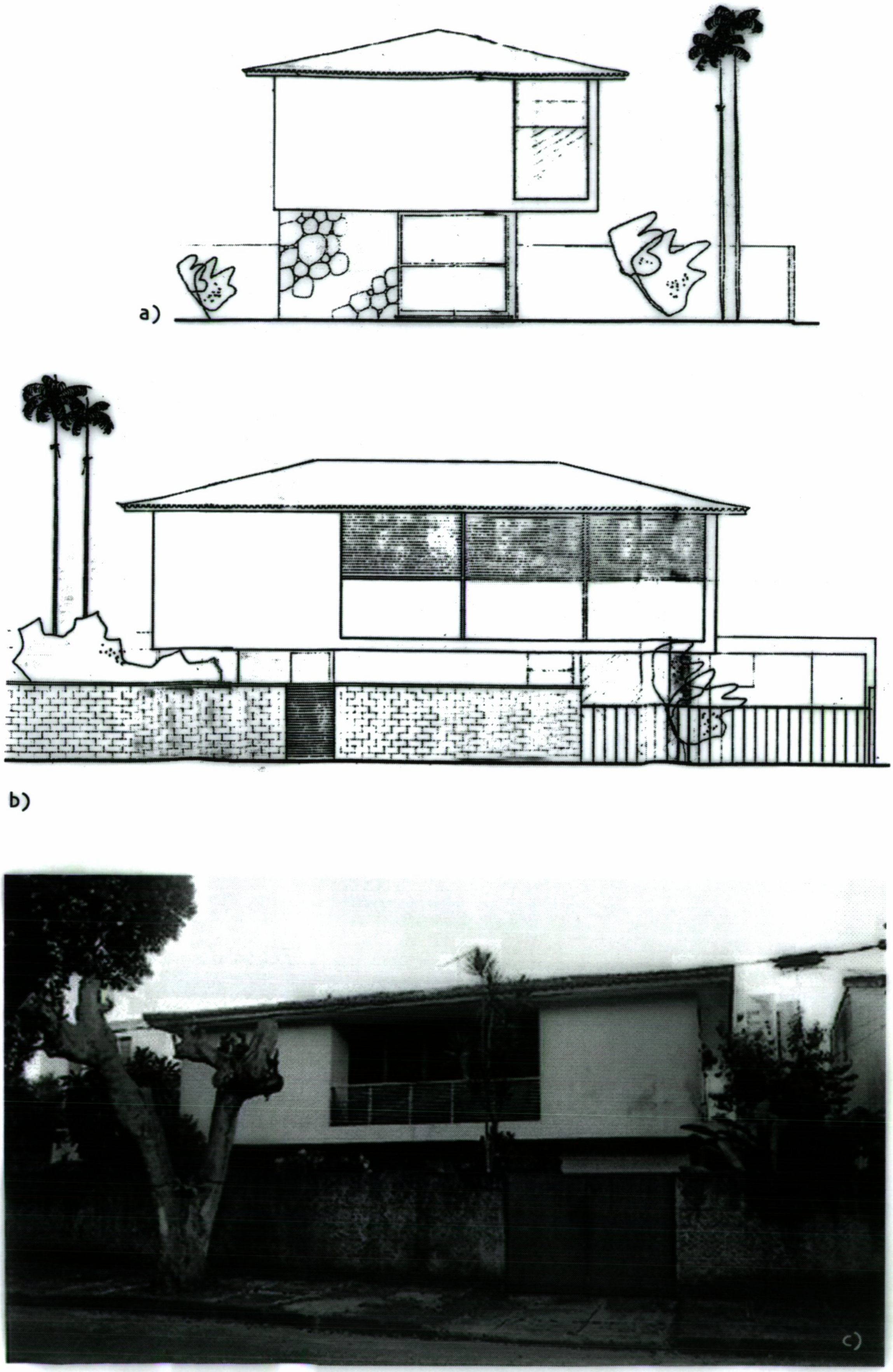


Figure 2.20. Esteves House: a) South façade b) West façade c) photograph

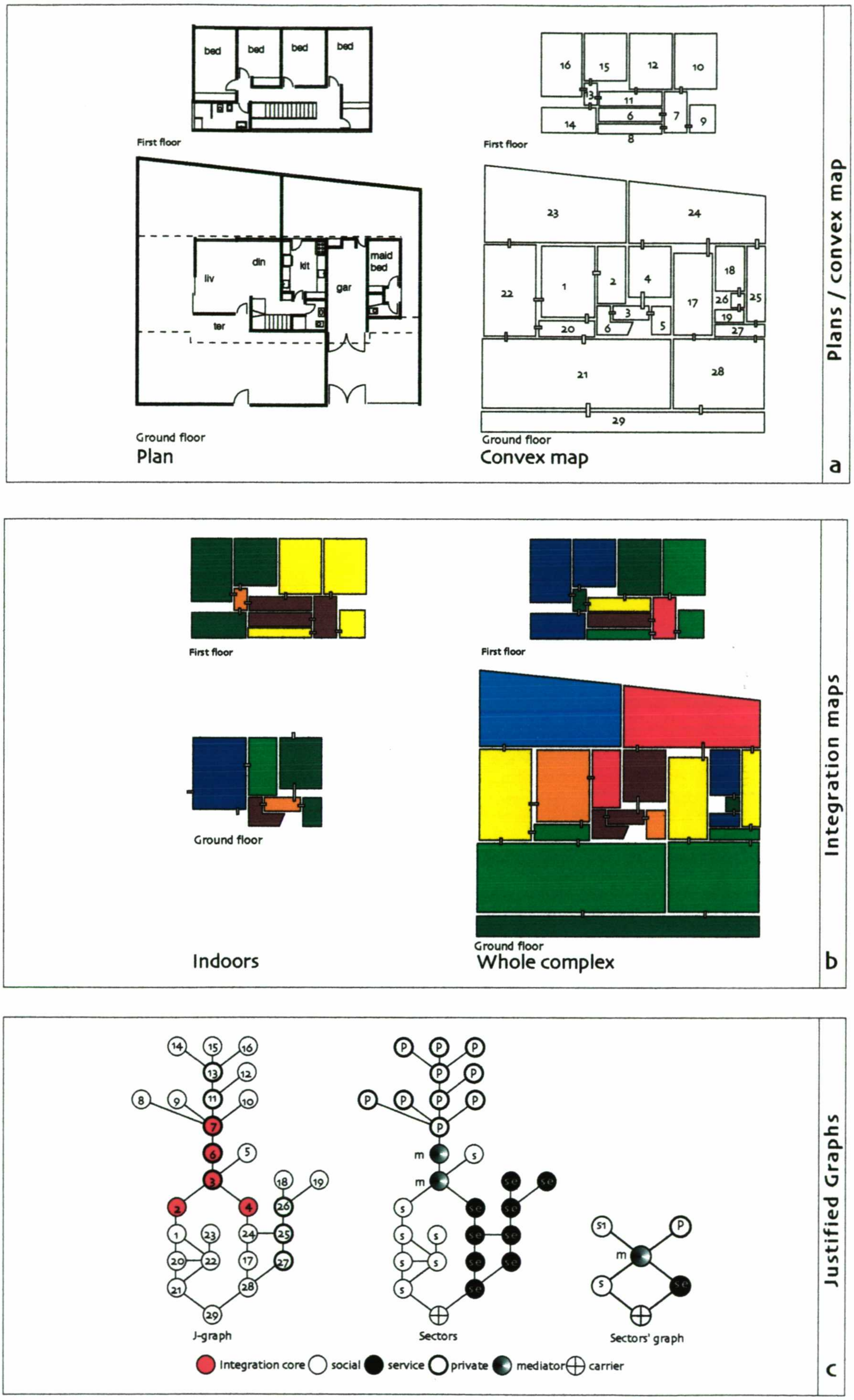


Figure 2.21. Esteves House: a) plan and convex maps b) integration maps c) justified graphs

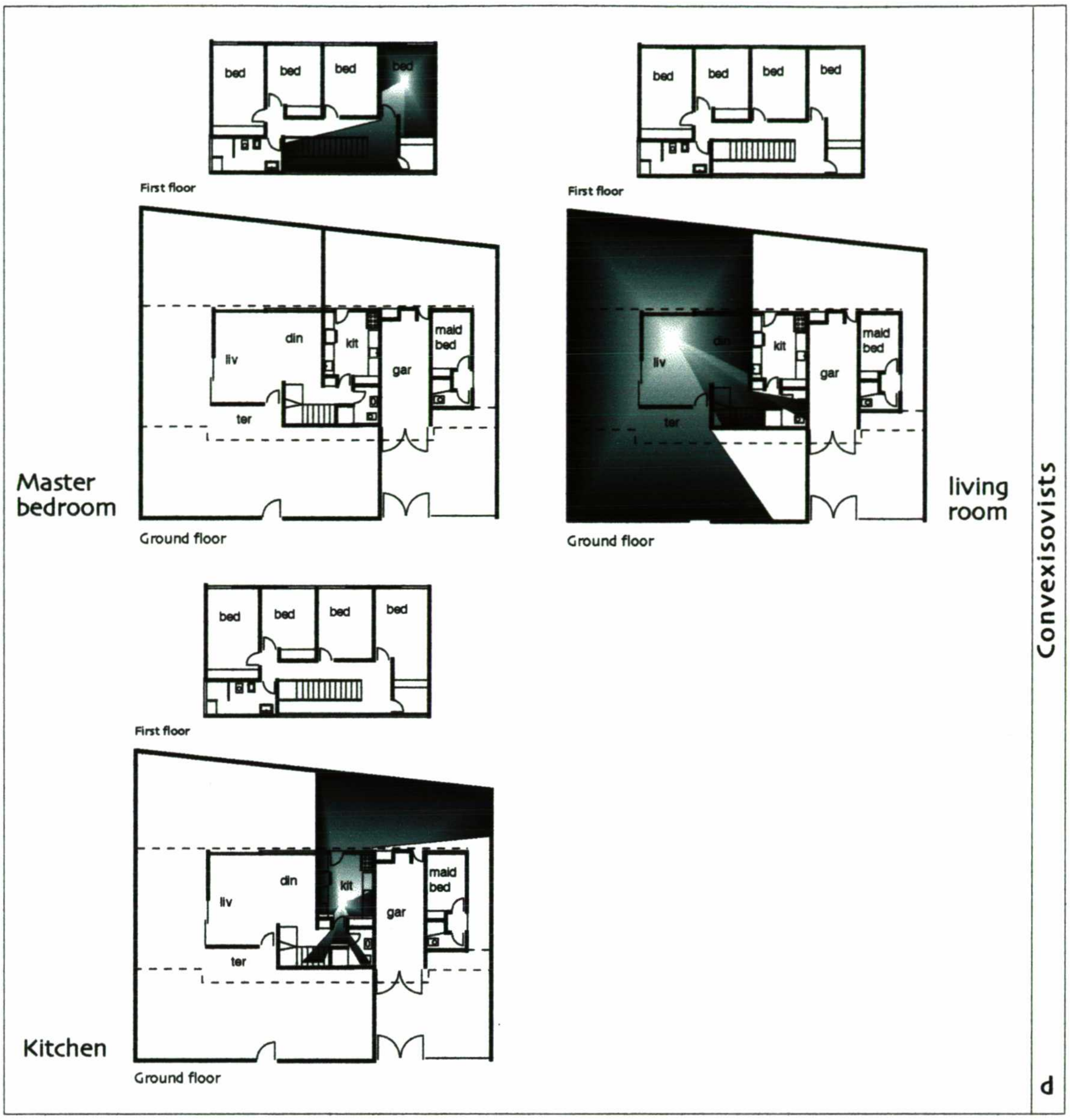


Figure 2.21. Esteves House: d) convex isovists e) visual integration maps

All existing rings include the outside spaces and are differentiated by sectors. One is formed by the main entrance, living room and garden; the other by the service outdoor spaces through the garage. Service and social areas are included in a ring only when the exterior is included, demonstrating the degree of segregation of both realms, and the strategic position of the kitchen in managing their reunion.

This unusual isolation has important effects in the integration of indoor and outdoor spaces. Functional service spaces are more integrated than social or private ones in both systems. The kitchen and the quintal are the focus of functional integration, towards the back of the house, reproducing the pattern found in pre-modern houses of Recife (Amorim, 1995b). These spaces are followed by the dining room and the north garden. Private spaces are situated at the lowest bands of integration, as well as the service quarters. Indeed, integration is dispersed from the transitional core centrifugally, upwards, to the private sector, and outwards to the exterior and maid's accomodation.

The visual isolation between the main spaces of each sector is again manifested in the isovists from the kitchen, living room and master bedroom (figure 2.21.d.). The visual integration shows a very well-integrated first floor plan, resulting from the 'surveillance effect', or the visual control of the bedrooms over the spaces below. The stairs is the most visually integrated indoor space. The living room is shown to be relatively integrated, contrasting with the segregated kitchen. This inverted model suggests that, whereas the kitchen is fundamental in controlling access through the house, it has to be visually isolated. The degree of cognition (figure 2.22.) demonstrates this contradiction in the house, particularly when the outside spaces are included (0.122), partially corrected within the house (0.502).

Esteves House is profoundly determined by the zoning concept, being almost its diagram. Its parts are isolated from each other configurationally but also visually. Isovists from the main indoor functional spaces show how this isolation is further reinforced by secluding them visually. Visibility between sectors is only achieved from the first floor towards the outdoor areas. The house does not create spatial excitements. Its spatial and volumetric composition, as centrality, symmetry, and compartmentalisation, are very much in balance. The boredom of the spatial arrangement, is compensated by building's elaborated details.

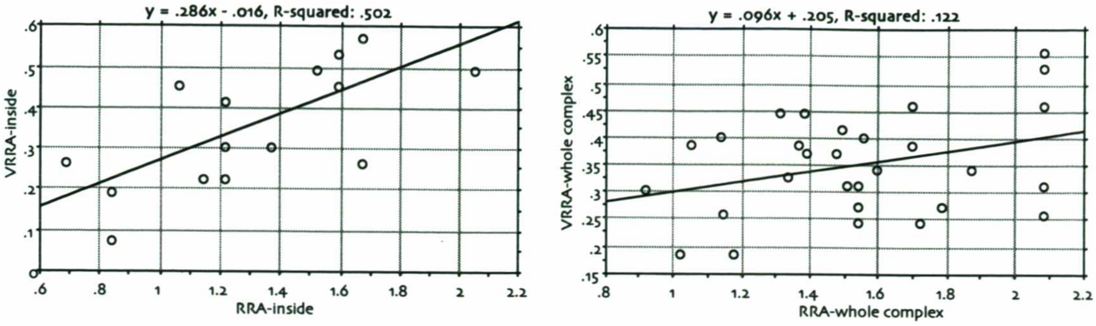


Figure 2.22. Esteves House: cognitive value

2.4.5. Marcos Domingues House - 1963

Marcos Domingues da Silva (1928-) graduated from the *Escola de Belas Artes do Recife* in 1953, where he became assistant, in 1960, and then Reader in theory of architecture, until his retirement in 1987. In parallel, he worked at the *Prefeitura da Cidade do Recife* (1959 to 1979), where he developed several plans for the city; and ran a successful private office (Domingues, 1998).

Domingues House was built in the suburb of Casa Forte, in 1963 (figure 2.23). The architect took the advantage of a steep slope to create an internal patio and a playground at the level below, and to place all the other compartments surrounding the patio, at the street level (figure 2.24.). The 'L-shape' plan distributes social and private areas, in each wing. The joint is occupied by the *copa,* a space used for informal meals, popularised by the eclectic houses in the last decades of the nineteenth century. The dwelling appropriates vernacular and modern elements. Tradition is present in the forms and labels of some spaces (the copa, the deep terrace or *alpendre*, as found in traditional rural houses), in the extensive use of verandas and traditional materials (ceramic tiles and wood), and in the use of thoroughfare rooms. Modernity is present in the use of concrete and spatial transparency.

Domingues sectors' graph is symmetrical to Reynaldo's, with the private sector connected to the social one, instead of the service. (figure 2.24.c.) The house is internally tree-like, but it becomes very ring-shaped when it is opened to the outside. The rings cross all the sectors of the house, but the remarkable internal and external permeability of the private sector makes this house a unique case in the sample.

The house is one of the most integrated of the sample (mean RRA, 1.261; BDF of 0.874). It is unusual for some aspects: the use of thoroughfare rooms and the use of the veranda as an alternative corridor to access the bedrooms. This organisation gives a high degree of integration to the social veranda, but also connects the private veranda to the bulk of the most integrated outside spaces

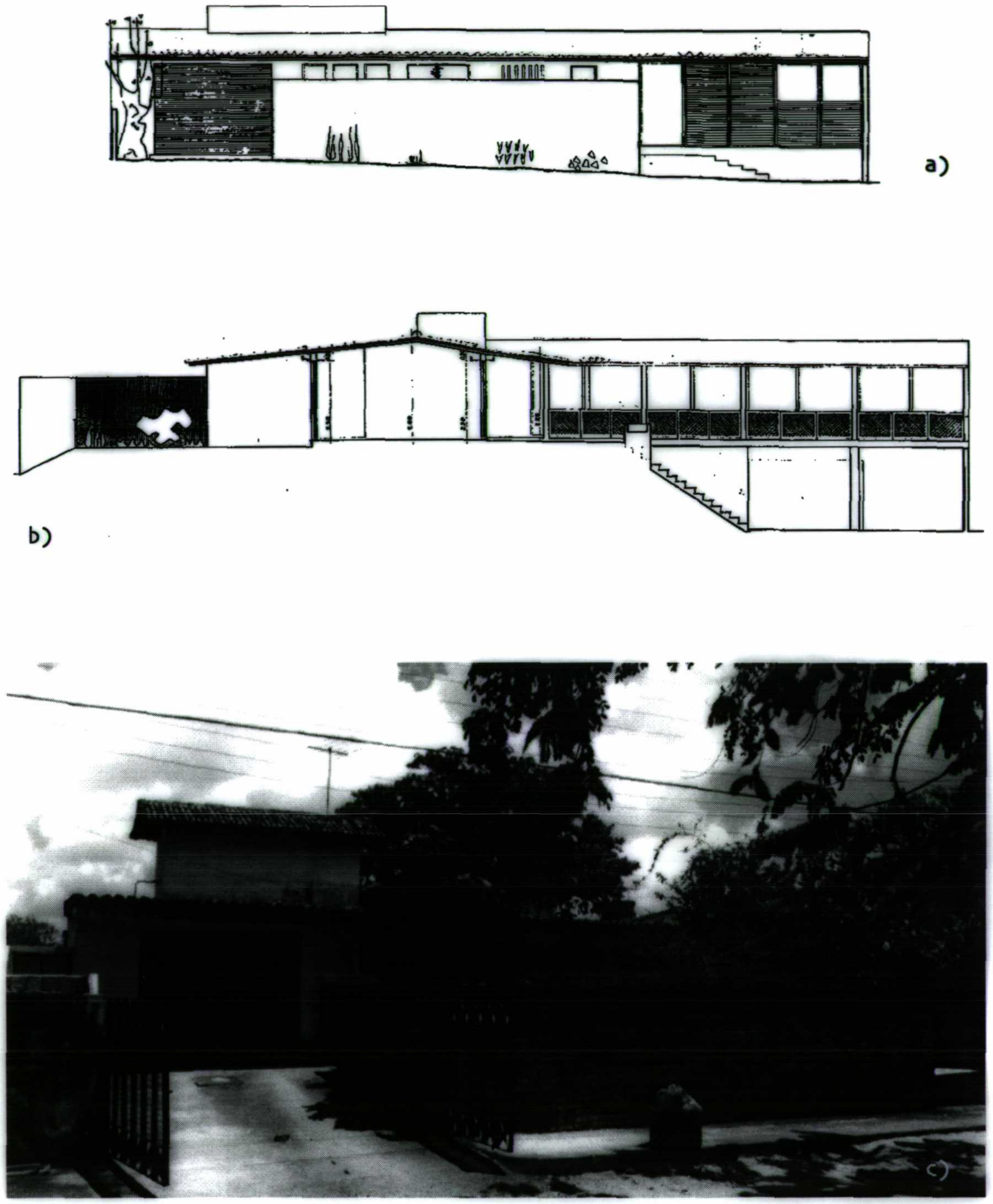


Figure 2.23. Domingues House: a) main façade b) section c) view from the street

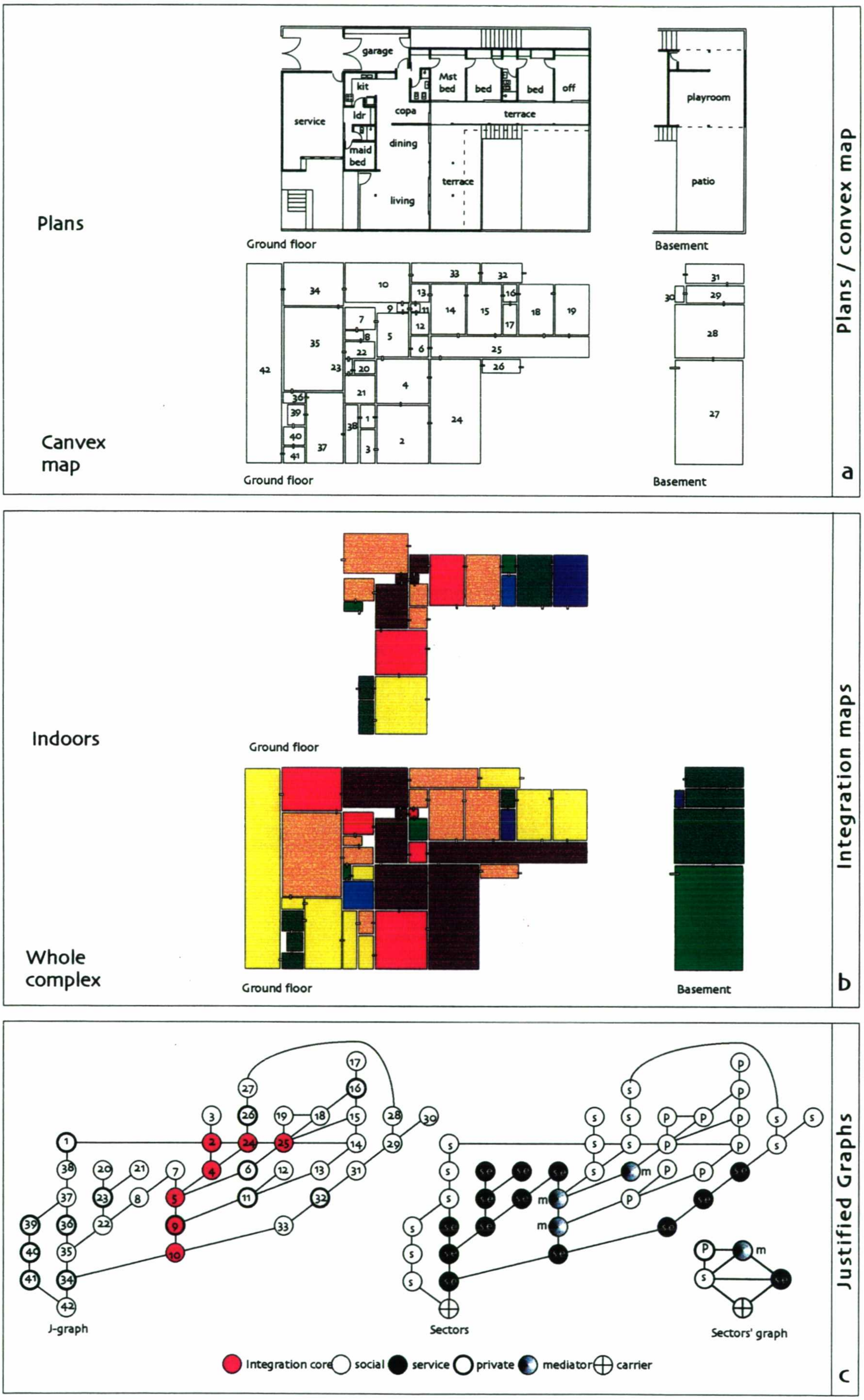
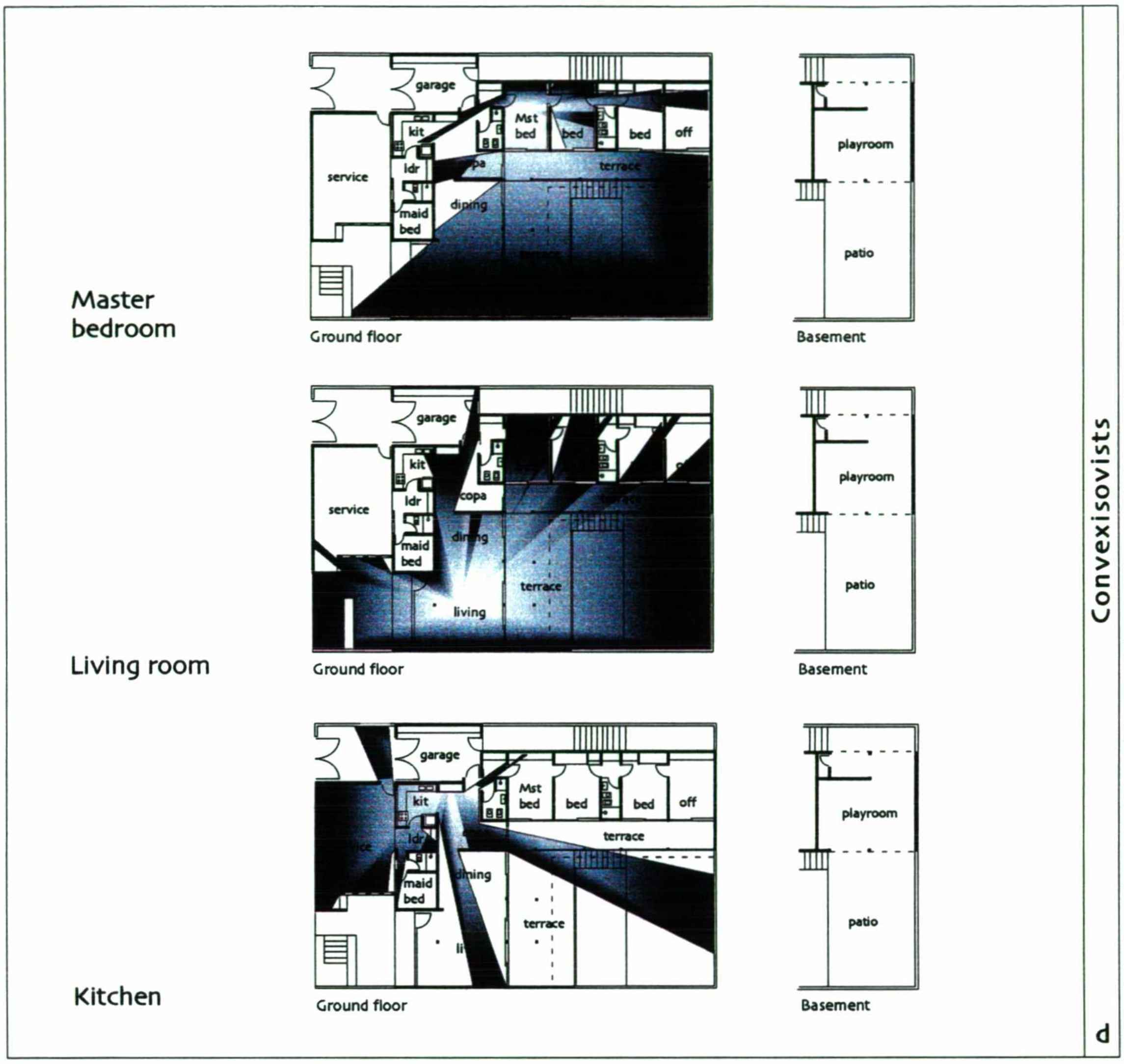


Figure 2.24. Domingues House: a) plan and convex maps b) integration maps c) justified graphs



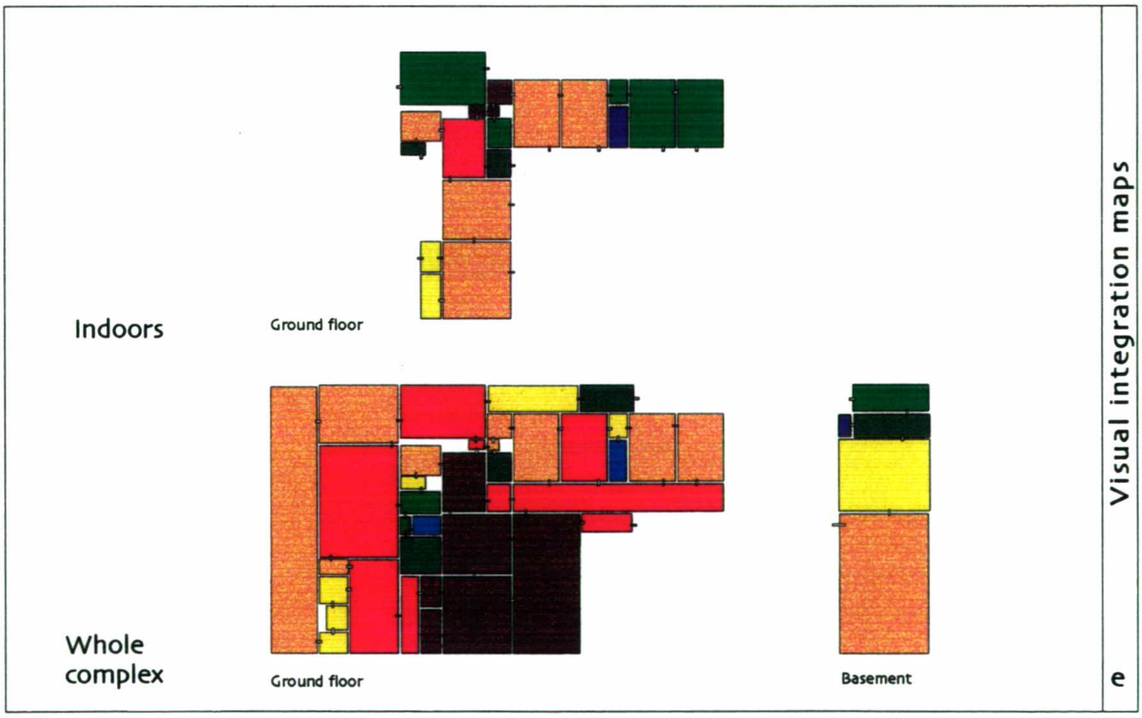


Figure 2.24. Domingues House: d) convex isovists e) visual integration maps

(figure 2.24.b). Organised around the patio, the core of integration is situated at the junction of the two wings of the 'L-shaped' house. The most integrated space is the *copa*, the space which mediates the access to the social, service and private rooms. It seems that the architects' intention on reproducing some aspects of vernacular tradition has also embedded in the plan some of their configurational properties. Indeed, previous studies have found that the *copa* had an important role in isolating service from family area, as well as, being the centre of the daily family life (Amorim, 1995b).

Uniqueness is also expressed in the visibility pattern of the house (figures 2.24.d. and 2.24.e.). The main functional spaces of each sector are within their visual fields, although the kitchen is quite secluded. This transparency is expressed by house's visual integration, which is on average the most integrated of the sample (0.340), indoors, and below the average value for the whole complex (0.269). Moreover, its high cognitive value for the whole complex (0.555) is the highest of all. Indeed, the external and internal complexes are more intelligible than the building itself (0.493) (figure 2.25). This is the only occurrence in the sample and demonstrates how the dwelling is outwards oriented .

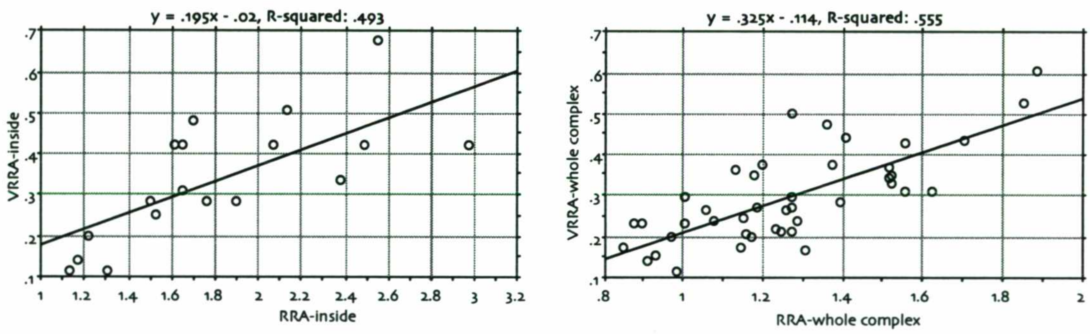


Figure 2.25. Domingues House: cognitive value

The idea of combining vernacular and modern elements was the main source of inspiration for a generation of modern architects. Domingues passed through this phase and his house is one of the finest examples of this architectural trend. His knowledge of colonial architecture gave him the necessary confidence to recreate it, without producing fake or kitsch architecture. On the contrary, this house is an example of how traditional form and space can be reinvented, while maintaining most of its syntactic properties. Domingues is a man of traditional values, and his house is nothing more than a sheer expression of his convictions.

2.4.6. Glauco Campello House - 1967

Glauco Campello (1934-), started his studies in Recife, but graduated in Rio in 1959. Between 1958 and 1961 he worked for Oscar Niemeyer, first in his office, and later in Brazilia, developing projects for the new capital. He returned to Recife in 1965 to assume a post at the school of architecture. In 1972, Campello, invited by Niemeyer, moved to Milan to develop the project for Mondadori's Headquarters. Returning to Brazil in 1975, Campello established his career in Rio de Janeiro, where he ran his office. During the 1980's Campello became involved with the restoration of historic buildings, assuming the presidency of *Instituto do Patrimônio Histórico e Artístico Nacional - IPHAN*, the Brazilian national heritage institute, in 1994 (Campello, 1998).

Architect of public and governmental buildings, his most important dwellings were designed in Recife (figure 2.26.). His house was designed in 1967, for his family of two daughters and a son. The typical 12.00m frontage plot, with an unusual 52.00m depth, was explored by the architect to generate gradients of privacy. This ground-floor-terraced house, is composed of three blocks; the service edícula, at the front; the social volume, arranged in parallel to the street; and a deep private block (figure 2.27.a.). Private and social areas form an internal patio, 'an exterior living zone' (Campello, 1982), secluded from the public eyes. The house can be described as fluid and open. Low internal partitions and furniture allow space to flow uninterruptedly, for example in children's bedroom and in the open kitchen.

Campello House introduces an external mediator as a buffer zone between the house itself and the pavement (figure 2.27.c.). For some architects, recessing house's wall, widening the pavement and often displaying gardens for the pleasures of the passers-by, was a way to enhance the quality of street life. As a personal attitude, independent from the urban design context, most of the recessed entrances appeared awkward, and its effect was to further isolate the house from the street. The sectors' graph pictures this effect and the way privacy is established in the house by using mediation. Internally, the house is tree-like. A local ring is formed by the hall, office and living, around a low partition, separating inhabitants and clients entrances. However, these spaces are visually and permeably connected, and for this reason the office was more likely to have been used as a receiving room, rather than as a room to working. Rings are mostly formed with the outside spaces, confirming their importance in configuring the house. The ringiness of the social area, with every single social space opening to the terrace, is remarkable.

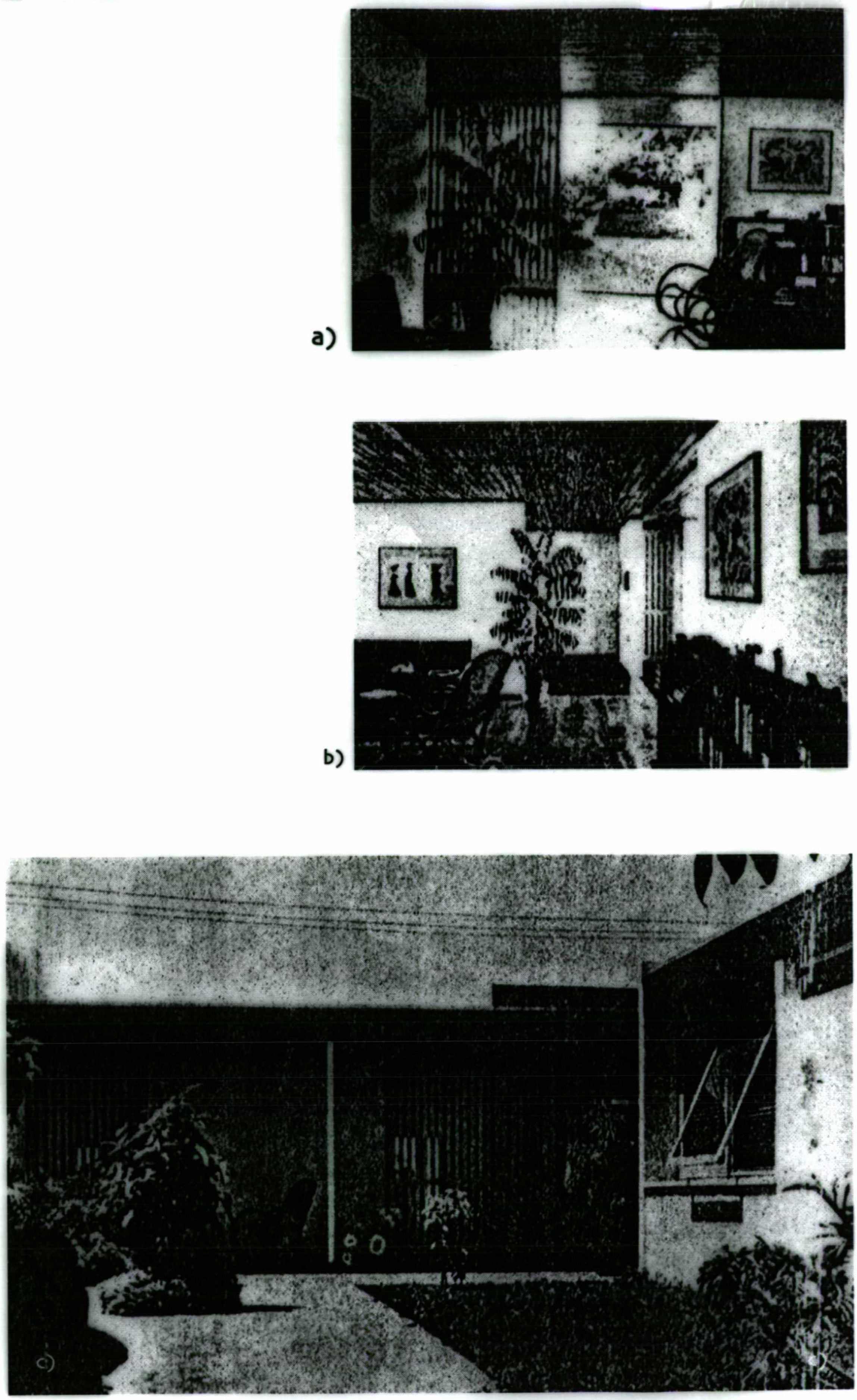


Figure 2.26. Campello House: a) and b) living c) patio, after Campello, 1982

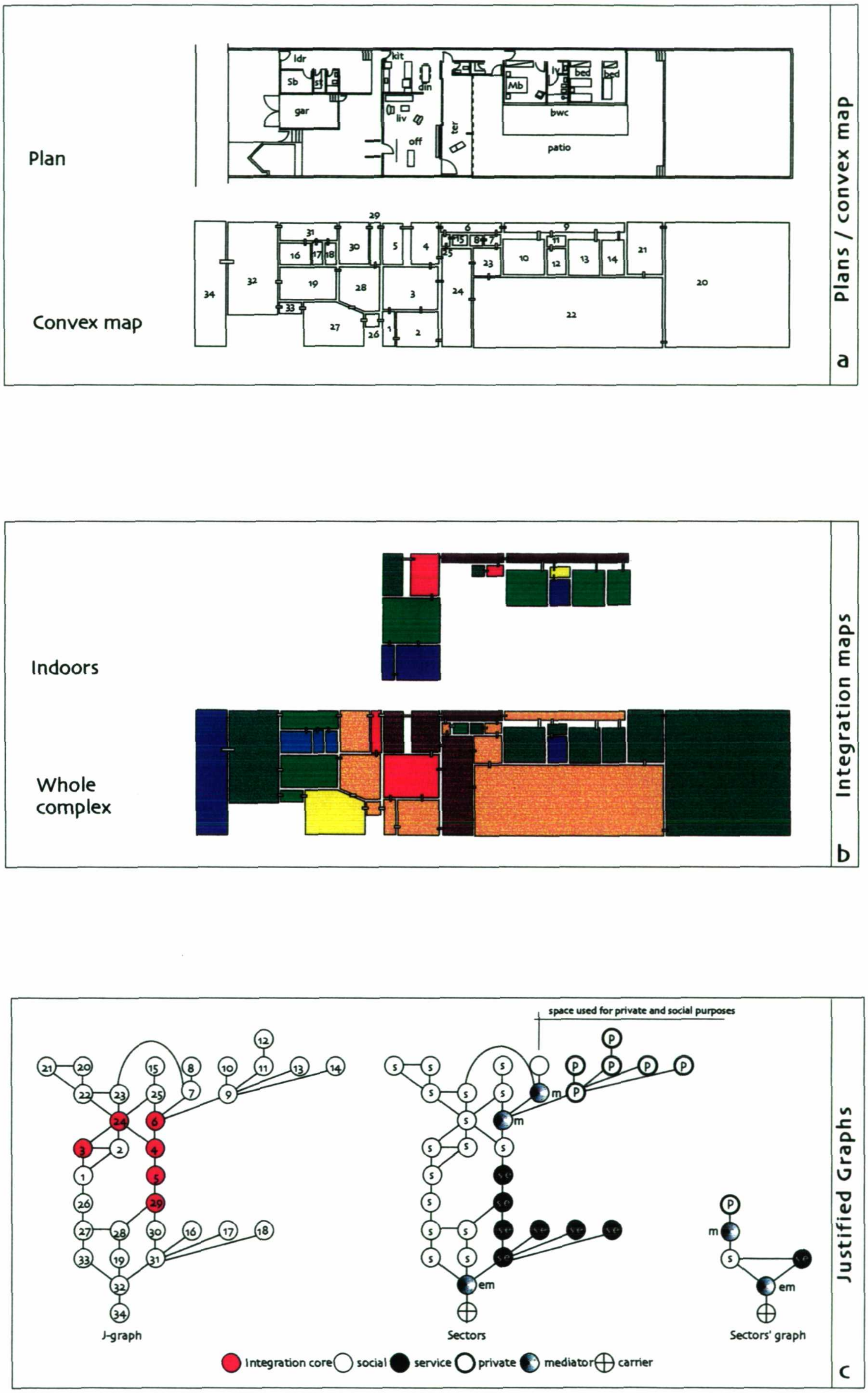


Figure 2.27. Campello House: a) plan and convex maps b) integration maps c) justified graphs

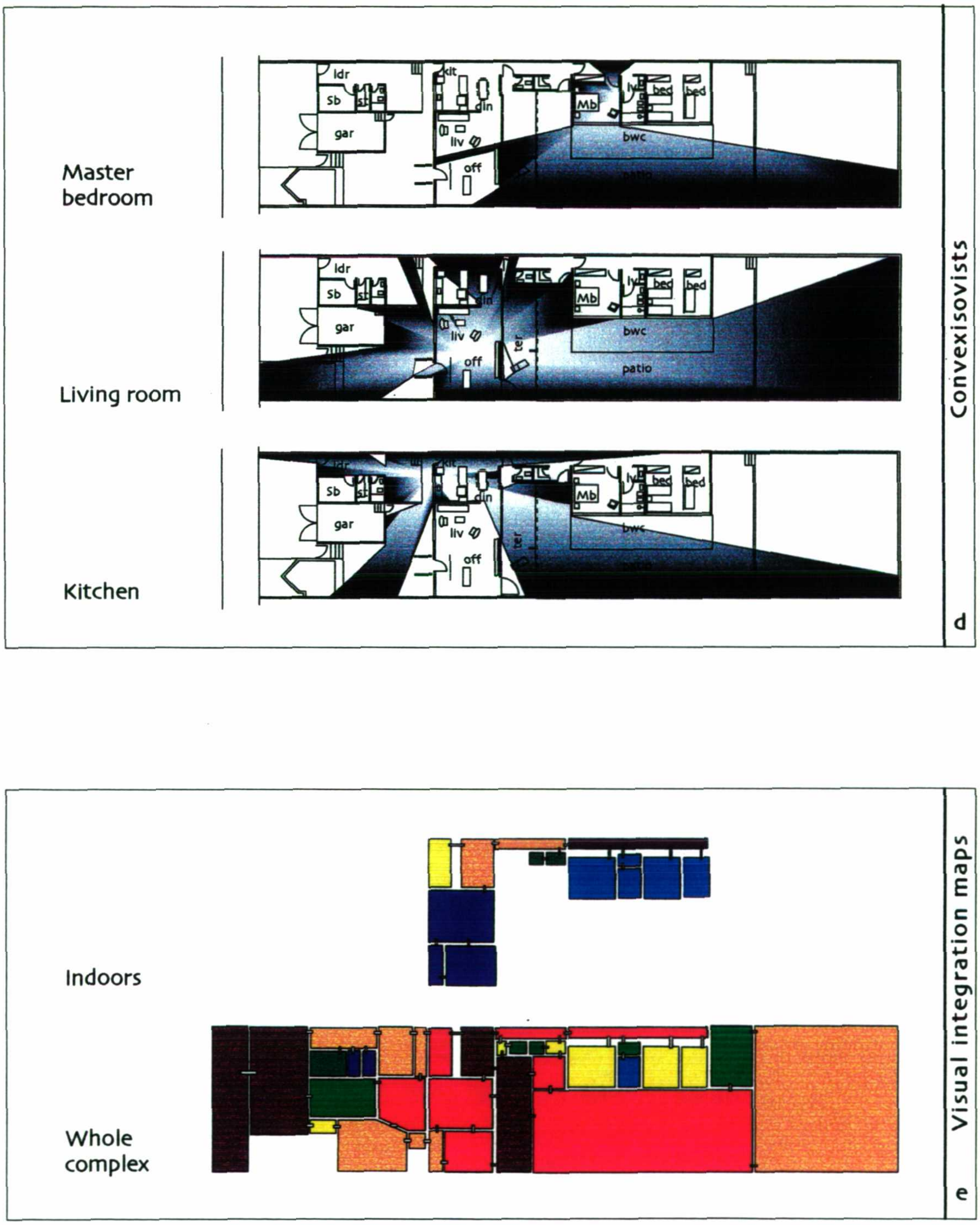


Figure 2.27. Campello House: d) convex isovists e) visual integration maps

This informality is reflected in the integration pattern (figure 2.27.b.). The dining room is the most integrated space of the complex (0.754), as it manages the main access from all main parts of the house to all others. It is followed by the kitchen (0.844) and the mediator-corridor (0.877), the passage from sociality to privacy. The house has a mean integration of 1.279, which is close to the average for the sample, 1.350. It is also reasonably differentiated, with BDF of 0.845. The key factor for this pattern is the junction of the 'L-shaped' volume, which is occupied by the dining room. It seems that Campello, aware of this 'junction-effect', has invested in configuration to generate a vortex of social and family encounters, differently from Domingues House, which has clearly differentiated formality and informality. The integration core of the house corresponds to the spaces adjacent to the dinning room including social, service and mediator convex units. The terrace is the most integrated social space, reflecting the architect's intention in focusing domestic life on the patio. The high levels of integration of the social spaces, both indoors and outdoors, reaffirms the tendency of modern houses in integrating social spaces and segregating service and private ones.

The living room, kitchen and main bedroom are not entirely secluded from each other, but their visibility is quite reduced (figure 2.27.d.). The living room is the only space that sees both, since the kitchen and the main bedroom are secluded from each other. The terrace, however dominates, all social and private spaces, as well as the kitchen. In fact, the terrace is the visual core of the house. On the other hand, the seclusion of the bedrooms is strong and efficient. The corridor is the only space to be seen from them. The integration map shows a 'warm' plan, i.e., with most of the spaces situated at the highest levels of integration. Notwithstanding the relative high integration of its spaces, the house has one of the lowest mean visual integration of the group (0.291). The house itself is even more segregated, the second in the sample, with 0.597. as an effective consequence of the visual isolation of the bedrooms. A visual isolation correlating with permeability segregation, corroborating to give a sensitive degree of cognition (0.536). The introduction of the outside slightly alters this pattern by reducing buildings cognition to 0.446 (figure 2.28.)

It is known that sparse financial resources have limited architect's ambitions while designing his residence (Felipe Campello, 1997, pers. comm.). However, the simplicity of the house's design is its merit. The economy of means and perfect regularity of the plan is one of the characteristics of Campello's work.

His house is an exercise in formal contention and spatial expansion, but without great gestures. His ability to generate an informal atmosphere in the dwelling is due to the sensible integration between the internal and external living spaces, forming a quiet and isolated domestic hearth.

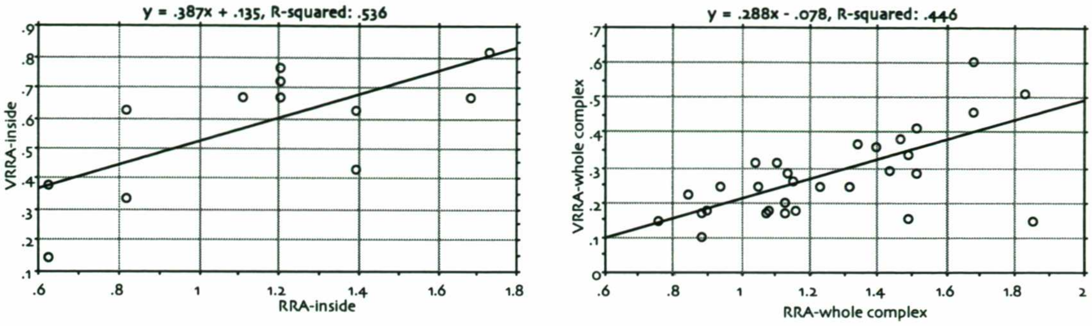


Figure 2.28. Campello House: cognitive value

2.4.7. Frank Svenson House - 1969

Graduated from Belo Horizonte in 1962, Svenson moved to Recife in 1963 to work for the Brazilian regional planning agency, SUDENE. At the same time he worked in association with Domingues, until being appointed a lecturing post at the *Universidade de Brasilia,* in the early 1970's. His later career took him both to Strasbourg and Luanda - where he was involved in the creation of an architecture course and later, to Sweden. He is currently teaching at the *Universidade de Brasilia - UNB*.

His house, which was rewarded as the best residence of the 1969 *Instituto de Arquitetos do Brasil-Departamento de Pernambuco* Prize (Santana, 1969: pp 15-17), is set at the centre of an ordinary suburban plot of Olinda (figure 2.29.). There are no subtleties or sophistication in the building; however, its spatial organisation is very distinctive (figure 2.30.a.). Firstly, the house is highly permeable to the outside, similarly to Domingues house, without any thoroughfare rooms. Secondly, the servants' accommodation is undifferentiated in the house, possibly expressing architect's Marxist beliefs in a classless society. The plan anticipates the 'reversible bedroom', commonly used in contemporary flats, allowing its use either by the family or servants. In this case, the reversible bedroom is aiming at flexibility, rather than social equality.

The simplified sectors' graph is composed of seven nodes (figure 2.30.c.). The front garden works as an external mediator, as there is no differentiation between social and service access to the house. The bathroom is recessed from the social area, and accessed through the corridor, which mediates the access to the private sector and service areas through the maid's bedroom.

Figure 2.29. Svenson House: a)and b) living/dining c) West façade, after Santana, 1969

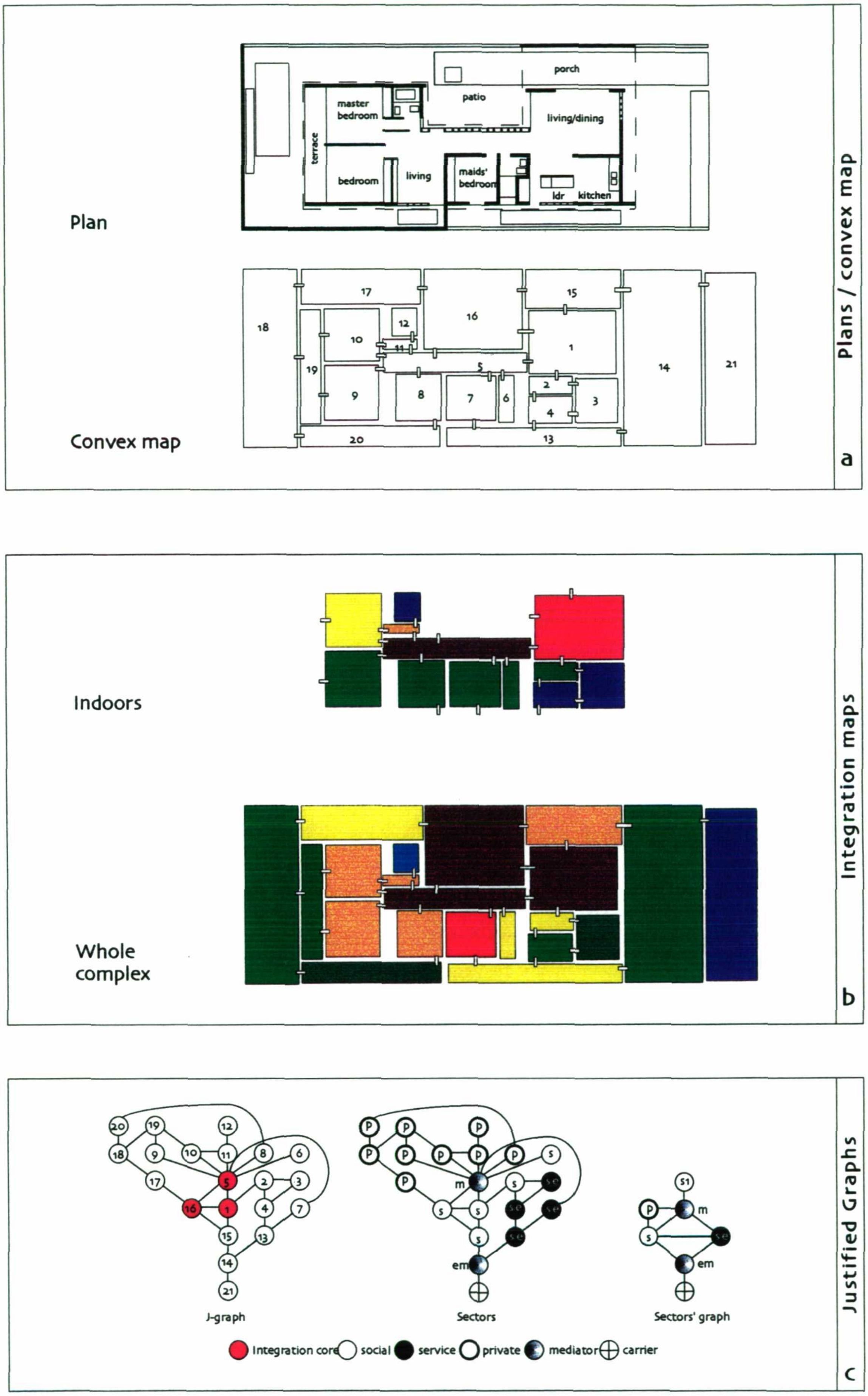


Figure 2.30. Svenson House: a) plan and convex maps b) integration maps c) justified graphs

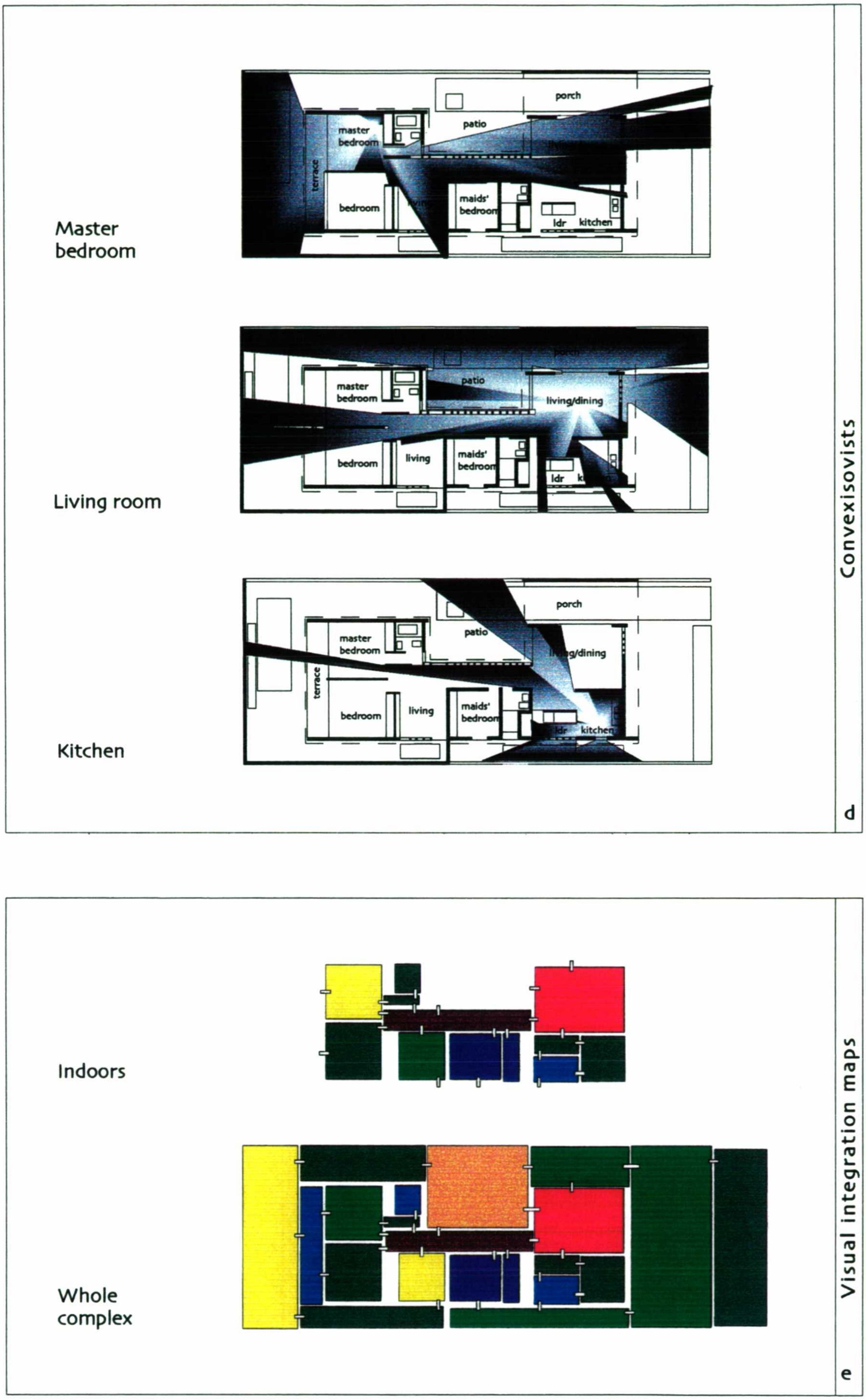


Figure 2.30. Svenson House: d) convex isovists e) visual integration maps

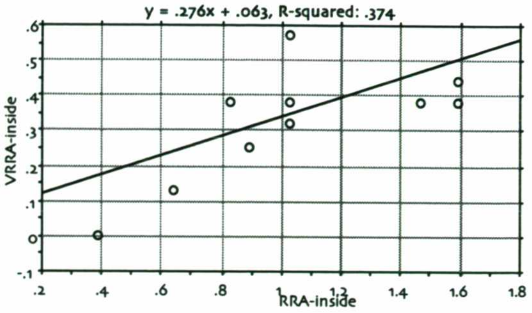
Social and service nodes are d-type spaces, whereas the mediator is a c-type space. The private sector, becomes a c-type space as a result of its connection to the garden, allowing for an alternative route to the social area, avoiding the central corridor.

This transitional-centred house is the most integrated of all (0.884) and also the most differentiated one (0.735). Rings abound for its openness to the gardens. Rings cross every single indoor and outdoor space, in every sector, apart from the bathrooms. The central 'spine-like' corridor is the cortex of the house, linking all its parts. The house has an interesting integration core formed around the corridor, drawing indoor and outdoor living areas together. Visual links also reinforces the continuity of these three spaces. The distinctiveness of the maid's room is seen in its value of integration, which is the fourth in the house.

The transparency of Svenson's residence generates deep and generous isovists (figure 2.30.d.). The living room dominates most of the house from the front garden to bedrooms' garden, from the kitchen to the internal patio. Transparency is also evident in the isovists of the kitchen and main bedroom. Curiously, these three main spaces are the only interior convex units from different sectors to be seen from each other's spaces.

Although the dwelling's transparency generates high integration, forming the most integrated indoor system (0.351) and second most integrated outdoor system (0.247), its cognitive values are quite disappointing, 0.374, with, and 0.309, without the outside. Certainly the absolute visual centrality of the corridor (it sees all spaces of the house, therefore obtaining maximum integration, 0.000), combines to distort an even distribution of access and visual integration amongst the spatial components of the system (figure 2.31.).

Although the house is very much centred in the corridor, configurationally speaking, the house presents some interesting and unusual features. The high degrees of ringiness and transparency make the house an open shelter, with wide visual fields. This sense of openness is greatly contrasted by the darkness of the *brute* materials, giving a sense of the interior unexpected from a blind observation of the plan. Its simplicity and easy-to-grasp solution may appear to be spatially boring, but its ringiness and possibilities of occupation are the key qualities of its dynamic spatial system.



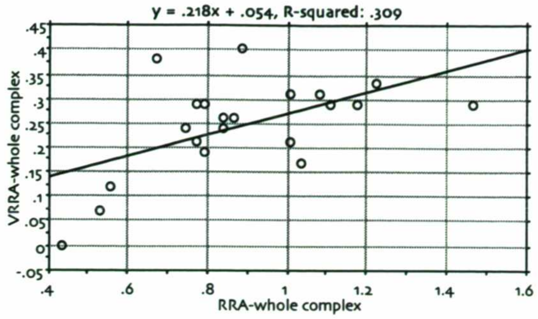


Figure 2.31. Svenson House: cognitive value

2.4.8. Carlos Fernando Pontual House - 1975

Carlos Fernando Pontual (1944-) concluded his degree course in 1968 in Recife. After working for *Casa Holanda*, a traditional furniture maker which successfully incorporated modern design, Pontual formed with Cunha Lima, *J&P Arquitetos,* a successful partnership, vendor of a significant portfolio of works and national prizes.

J&P projects are of a consistent economy of means and expressiveness of building's structure and Pontual house is an example of 'J&P style' (figure 2.32.) It is an interpretation of a 'box over pilotis', similar to Amorim House, another celebration of Corbusier's Vila Savoye, confirming the constant presence of Corbusier in Brazilian modern tradition. Standing over a green lawn, the compact squared volume is supported by pairs of steel pillars per façade. The contrast between the delicacy of the pillars and the robust concrete structure is one of the great achievements of this house. The dwelling is approached from its side, by which the visitor has the choice of access through a pedestrian and formal entrance, and a vehicle and informal entry (figure 2.33.a.). The formal entrance leads to the first floor, where houses' main spaces are. Bedrooms face north, service areas south, and living areas, east. The centre of the squared plan is occupied by a staircase which accesses the pilotis' informal entry. The pilotis is used for parking and leisure.

This residence is the only non-mediated system of the sample, even though an external mediator is used to isolate formal and informal entrances (figure 2.33.c.). The private sector is directly connected to the social area, without a buffer zone; the same occurs with the service sector. This solution enhances the role of the social sector in order to bind the whole complex together. Internally the house is a long and deep tree, with its centre at the social area. Two main rings are created with the outdoors: one crossing the social and service area through the main floor, and the other descending to the pilotis through the stairs. The private rooms, however remain without rings.

Figure 2.32. Pontual House: a) living/dining b) pilotis c) East façade

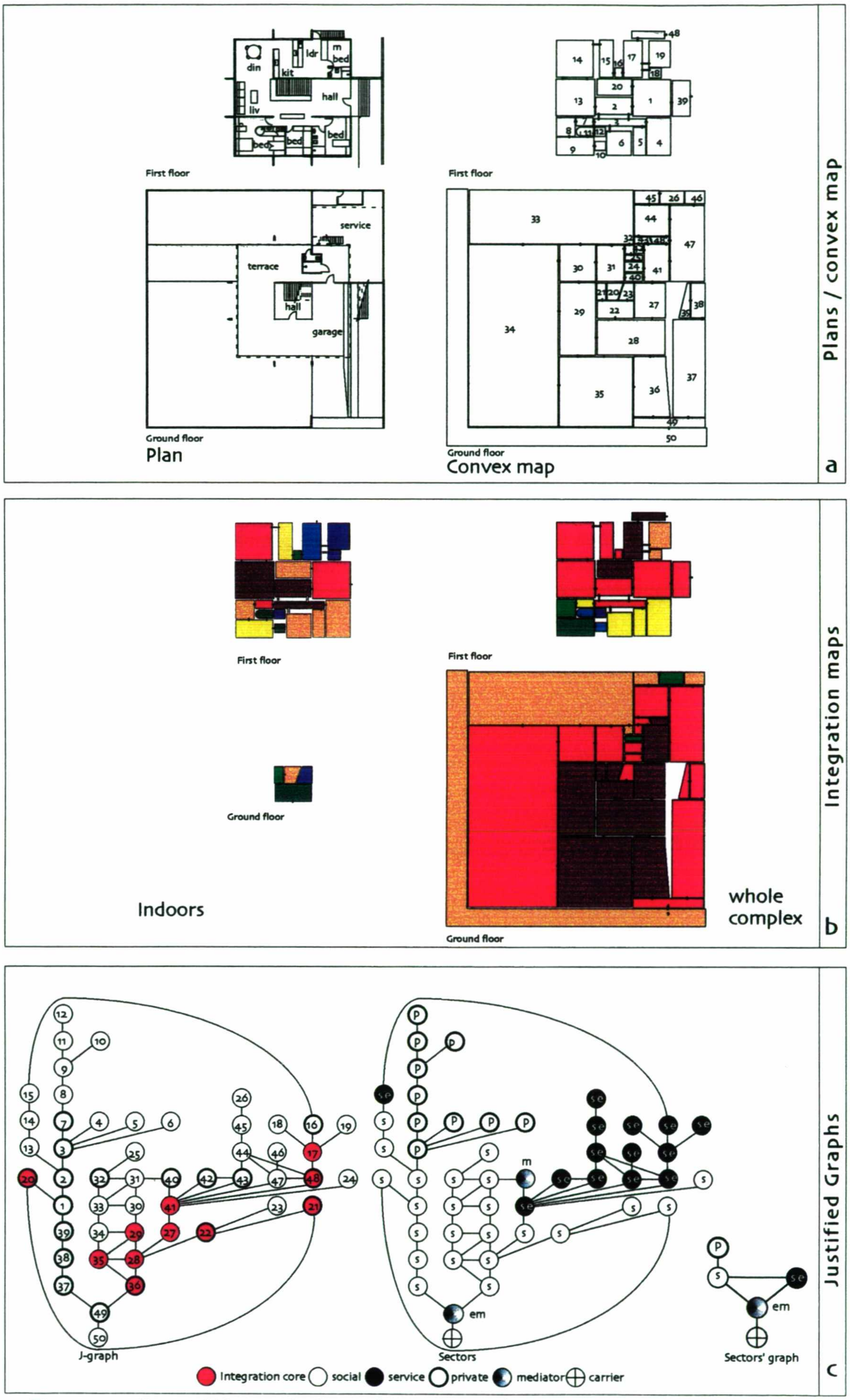


Figure 2.33. Pontual House: a) plan and convex maps b) integration maps c) justified graphs

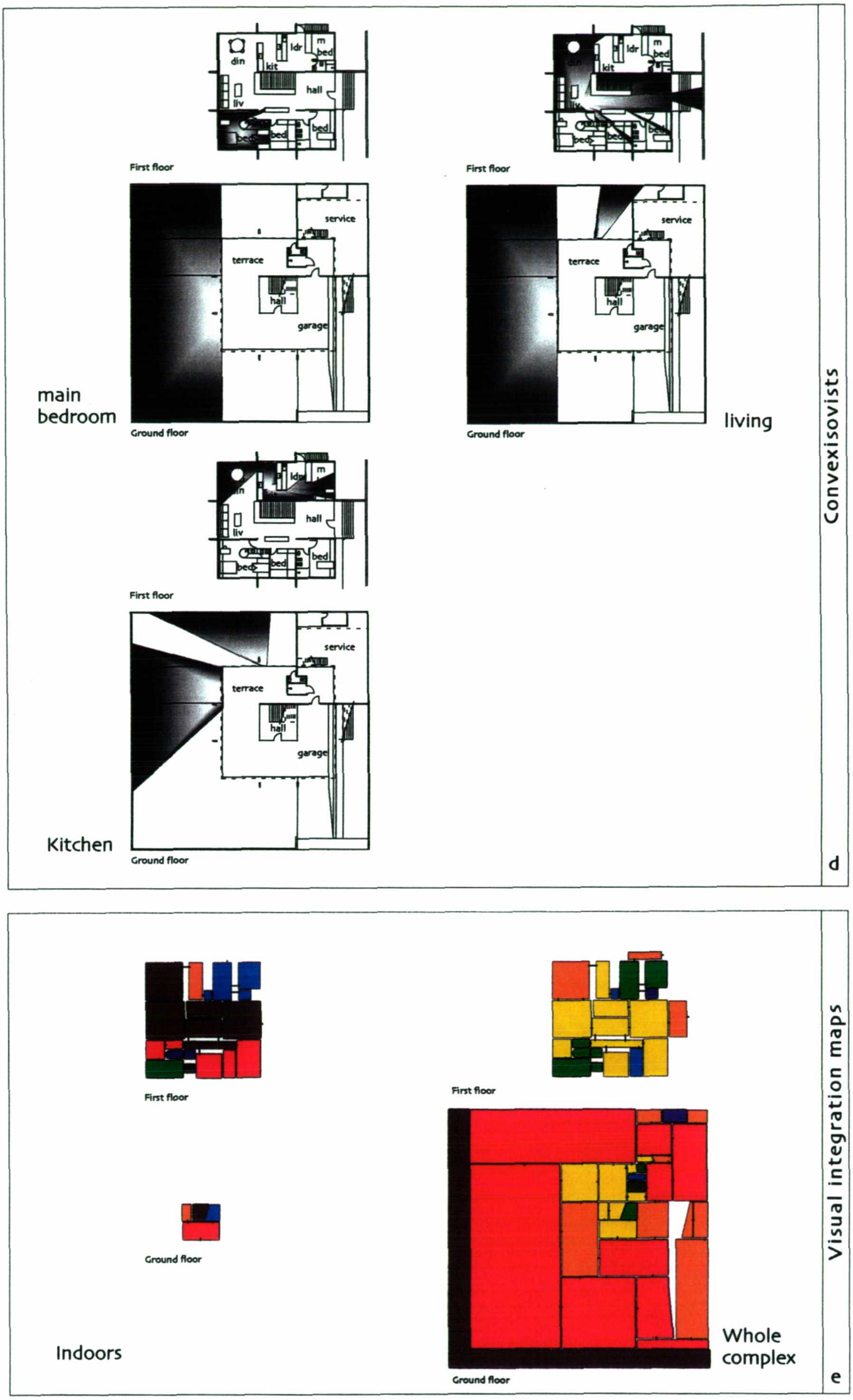


Figure 2.33. Pontual House: d) convex isovists e) visual integration maps

Pontual House has, as Amorim's, one of the lowest mean integration of the sample, 1.559, but it is highly differentiated (BDF, 0.791). Their similarities extend to the level of integration of the transitional spaces. In both houses, the vestibule is the most integrated space. The integration core of this residence is the largest of the sample, encompassing 22% of its spaces. It is also the shallowest and 'ringiest' one, involving spaces from the ground and first floors, and from the social and service sectors, but without including the main living spaces. The convex complexity of the pilotis draws integration to itself, as if the intensity of the family life should be concentrated at the outside, which indeed is the case.

Both indoor and outdoor social spaces are more integrated than the service ones (figure 2.33.b.). However, the laundry, connecting the house's interior to the backyard complex, is highly integrated. The terrace is the most integrated outdoor space followed by the *pergola*. This result confirms the tendency of modern houses to concentrate integration in the spaces for receiving and living, rather then in the service or private ones.

The much proclaimed transparency of this residence to its surrounding gardens induces a high value of integration (0.266), but this transparency is quite discrete, in a sense it is the outside system that corroborates this value (figure 2.33.e.). As soon as the house is analysed on its own, it produces the lowest visual integration of all, with 0.721. Yet, it is this tree-like interior system that creates the best correlation between visibility and accessibility amongst the houses (0.779) (figure 2.34.).

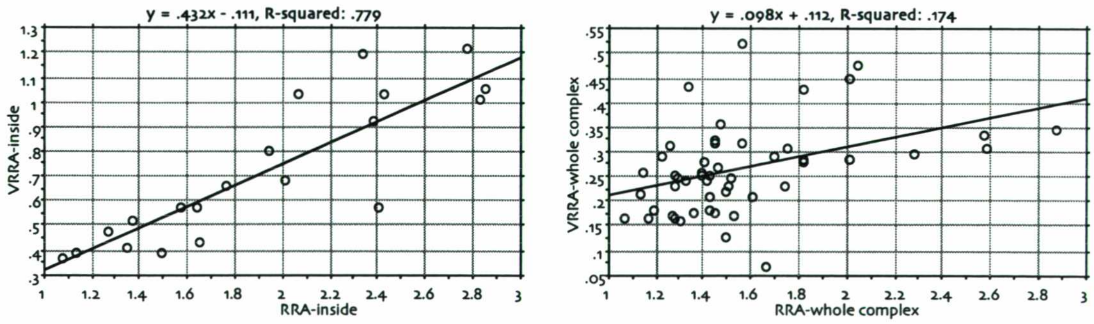


Figure 2.34. Pontual House: cognitive value

The ability to expand the visual field in the same proportion to the relative shallowness of each space is perhaps the best form to describe this house. In its interior the house is intelligible from its parts, but in its exterior the demand for extensive circulation reinforces the idea that in some spatial complexes, even at this size, cognition is only achieved through movement.

2.5. The spatial morphology of architects' Recife houses

2.5.1. A first approximation

Recife architects' houses show the diversity of Brazilian modernism (table 2.2.). The functionalist house is expressed by Borsoi and Reynaldo houses, the 'colonial contemporary'[19] by Domingues and Esteves houses, the brutalism by the Campello and Svenson houses, and the international style by the Pontual and Amorim houses. In terms of constructive systems, they range from Corbusier's 'dom-ino' model (Pontual and Amorim houses) to traditional masonry (Campello and Svenson houses), but the mixed system seemed to be more adequate to rationalise costs.

The diversity of the sample is better scrutinised by comparing some of its geometrical and topological characteristics (see table 2.1). Metric area and topological size, i.e., the number of convex spaces, is the first comparative analysis to be done. The houses' sites area ranges from 360.00 m^2 (Svenson House) to 900.00 m^2 (Pontual house), with an average of 529.46 m^2. If the usual Recife's urban plot ranges from 360.00 m^2 (12.00 x 30.00) to 450.00 m^2 (15.00 x 30.00 m^2), then three houses fall on the typical middle class size model. The architects' houses have an average area of 229.50 m^2. Svenson House is the smallest, with 121.90 m^2, and Amorim House, with its extensive roof terraces, the largest, with 492.67 m^2. Again, Amorim House constitutes an exception amongst the sample, which tends to be closely clustered over and above the average size. The area of the site has a positive statistical correlation with the houses' area, but a weak one, 0.411 ($p=0.0014$). This is due to the coefficient of occupation of the plot, directly dependent on the number of floors each house has.

The architects' houses have between 20 (Svenson) and 49 (Pontual) convex spaces, with an average of 35.88, for the sample. Unsurprisingly, the correlation between the area of the site and the total number of convex spaces is positive and significant (0.617, $p=0.0014$).[20] However, the correlation between area and topological size is more evident within the respective indoor and outdoor systems. The number of indoor convex spaces ranges from 19 to 33 (average of 22.50), and the outdoor ones between 8 and 23 (average of 13.38). The correlation values for indoor and outdoor

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[19] Expression used by Claudia Loureiro to refere to the Brazilian modern regionalism (Loureiro, 1996, pers. comm.).

[20] The correlation values are examined statistically using a test of significance called a t-test. The p-values express the probability that the correlation could have occurred by chance. The smaller the number the less likely to have occurred by chance. Values less than 0.05 are considered to be statistically significant.

systems are both positive and statistically significant, 0.783 ($p=0.0012$) and 0.721 ($p=0.0003$) respectively (figure 2.35.). These results demonstrate numerically what is intuitively expected: the bigger the house, the more convexially articulated it would be.

It is interesting to observe the sheer complexity of the outside systems of these houses. The elaboration is seen not only in the variety of space-use forms - patios, terraces, verandas, gardens, passages, pilotis, backyards, but also in their form and number. The ratio between the number of outside and inside convex spaces indicates the importance of the garden as part of the household complex. The average ratio in the sample is 0.615. Pontual and Domingues houses have the highest values, 0.885 and 0.864, respectively. Amorim is the less complex (0.242) for the compactness of its form.

The sample also shows a range of architectural *parti*, from courtyard houses to free standing compact blocks, from open to matrix-of-cells-plans. One way to evaluate how open or how compartmentalised the plans are, is to identify the number of enclosed spaces, i.e., rooms that may be isolated from the spatial system by means of doors and walls, which corresponds to a single convex space. The simple ratio between the enclosed or bounded spaces and the total number of the indoor convex spaces expresses how opened (low values) or how enclosed (high values) the houses are.

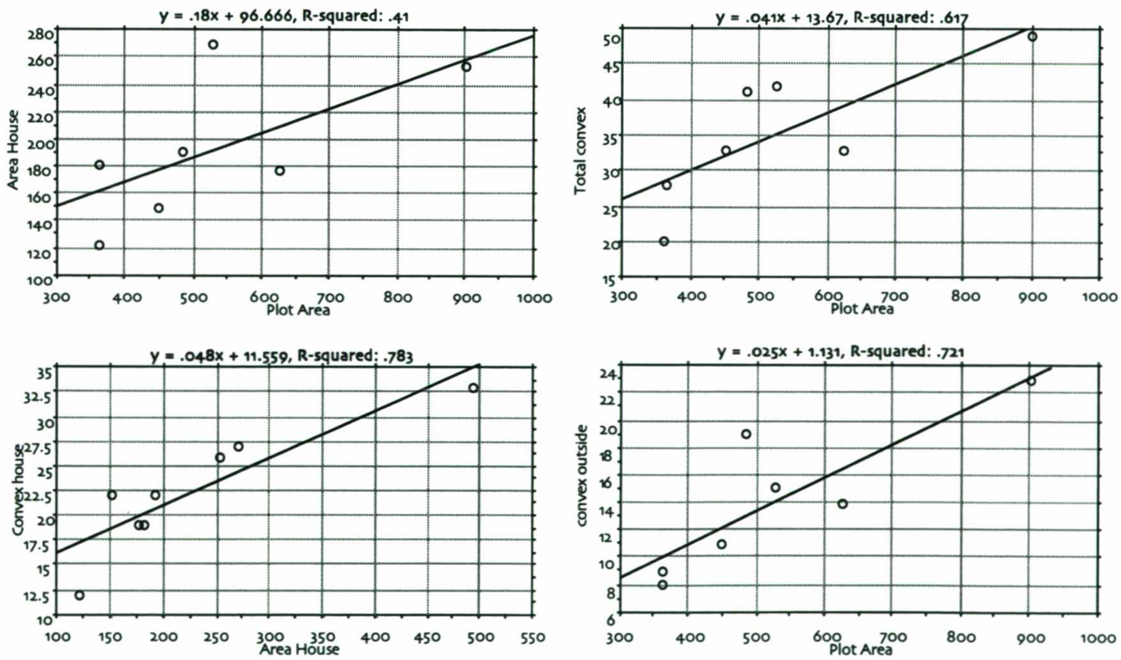

Figure 2.35. Correlation between area and number of convex spaces

The average bounded-convex ratio for the sample when considering the whole complex is of 0.405, meaning that almost 60% of houses' convex units correspond to a continuous flow of space. This is achieved by the articulation of an open circulation system, composed of hallways, vestibules, staircases, landings, passages and corridors, with the spatial continuity of some use-related spaces, mostly devoted to living and receiving activities. This is evident in Amorim and Reynaldo houses, for example, the less bounded of all (0.212 and 0.227, respectively).

These values are even more expressive if the outbuildings are discounted, as service compartments tend to be fully bounded. The average ratio becomes 0.312, and the houses appear more fluid and open. Five houses present values below the average. Reynaldo and Amorim houses stay as the least bounded houses (however Reynaldo becomes the least bounded of all), but Borsoi and Campello houses have a significant reduction in their values, representing, in the first, the openness provided by the central void, and in the second the spatial continuity amongst social spaces and the kitchen. However, it is the openness of the social areas, in contrast to the enclosures of the service and private spaces, providing the necessary sound and odour insulation, that characterises these houses. It seems that, as observed by Hanson in London architects' houses (Hanson, 1998: pp 236-237) and by Thomas and Ford, in their evaluation of the modern American houses (Thomas and Ford, 1961), the open-plan was more of 'a design philosophy rather a way of living' (Thomas & Ford, 1961: 9).

Convex spaces can be classified for occupation or movement. The first ones are large enough to be used for domestic activities, whereas the second ones are smaller and serve as connectors or thresholds between use-related spaces. One characteristic of modern houses is the use of an elaborate transitional system, convexialy articulated and composed of small 'lumps' of spaces. This spatial strategy aims at achieving a higher degree of privacy in a less compartmentalised and enclosed plan. Recife architects' houses display this spatial strategy, but in a less dramatic way. It is noticed, for example, in the chicane-like transition core in Reynaldo and Domingues houses, isolating both visually and permeably the private and service sectors in the first, and the private in the second. In spite of these cases, transitionality is generally less convexialy articulated.

Architects' Recife houses have between 3 and 9 transitional spaces and an average of 6 for the whole sample. The number of function related spaces ranges from 9 to 24 with an average of 13.88. The extreme values are found in Amorim and Svenson houses, as the largest and smallest houses of the sample. These absolute values are best evaluated when relativised to the total number of convex spaces of the house. The degree of functionality (DF) is the ratio between the number of use related spaces and the total number of spaces. The average DF value for the sample is 0.699. Reynaldo house is the more 'transitional oriented' house, with 0.600, and Svenson the more 'functionally oriented' house, with 0.750.

Values for house area correlate positively and significantly with the number of functional spaces (0.943 r^2, p=0.001), but poorly with the number of transitional spaces (0.464 r^2; p=0.0009) (figure 2.36.). These results show when the houses become larger, more spatial investment is given to functional spaces, either by creating spaces for specific uses, like the office, library, dining and recessed living in Borsoi House, or by providing bedrooms with en suite bathrooms, closets and verandas. Transitional complexity and house area is strongly related in London architects' houses, with an r-squared value of 0.825 (Hanson, 1998: 231), therefore indicating how transitionality is efficiently used to isolate use related spaces from each other. The values may indicate that privacy in Recife houses are not as important as in London houses. But isolation in Recife houses seems to be achieved with less spatial means, by concentrating transitionality in the mediator sector, thus imposing a 'sectors' isolation' rather then a strong space-to-space isolation.

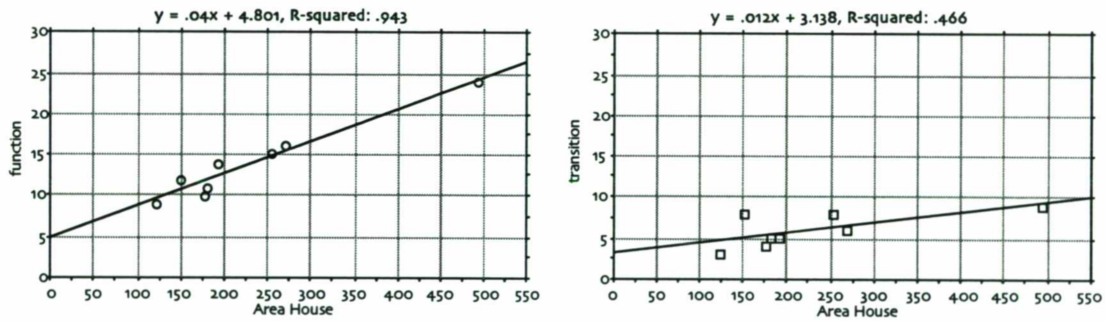

Figure 2.36. Correlation between house area and (a) function and (b) transition spaces

The relative importance of the transitional spaces in the configuration of the houses is seen by the tree-like structure of houses' interior. The average space-link ratio for the sample is 1.061, with values ranging from 1, a tree, to 1.167. Domingues, Esteves and Pontual houses are trees; Campello has a local social ring and Reynaldo a local private one; whereas Amorim, Borsoi and Svenson, have two local rings. Svenson present one private and a service/mediator ring, while Amorim and Borsoi have rings in the private zone.

This picture is altered with the introduction of the outside spaces. The average space-link ratio is slightly increased to 1.273, because the private sector tends to stay isolated. The houses are closely clustered around the average value, but Svenson House, with 1.429, is well above the mean because its intense connectivity to the outside, only seen in Domingues House. In the remaining houses, outside rings may cross the private sector (Reynaldo House), but they mostly occur amongst social spaces, living/dining/terrace, and between social and service areas.

The exterior is included in a ring in four cases (Reynaldo, Borsoi, Esteves and Domingues houses) when social and service entrances are distinguished. In three cases (Campello, Svenson and Pontual) the exterior is secluded by an external mediator, therefore the ring generated by the double entrance becomes recessed from the pavement. These three dwellings are the more recent of the sample, perhaps a reflex of Chermayeff and Alexander's (1963) concept of hierarchy and privacy.

The degree of ringiness is also captured by the topological composition of the houses, i.e., by the space types they are composed of (table 2.3.). The genotypical order of space-ness is *b<a<d<c*, characterising the higher percentage of spaces included in rings rather than in trees. This order is reversed when the outside spaces are retired, becoming *d<c<a<b*, with a very low mean d-ness value (figure 2.37.).

Table 2.3. Space-ness values

Houses	**Space-ness (inside)**					**Space-ness (whole complex)**				
	a-ness	b-ness	c-ness	d-ness	DV	a-	b-ness	c-ness	d-ness	DV
Amorim	0.34	0.52	0.18	0.00	1.98	0.29	0.28	0.24	0.19	0.41
Reynaldo	0.26	0.50	0.30	0.00	1.88	0.21	0.06	0.47	0.26	1.62
Borsoi	0.43	0.35	0.23	0.05	1.46	0.29	0.10	0.30	0.33	0.90
Esteves	0.67	0.43	0.00	0.00	2.43	0.39	0.19	0.24	0.21	0.81
Domingues	0.37	0.71	0.00	0.00	2.63	0.15	0.03	0.52	0.31	1.99
Campello	0.46	0.42	0.21	0.00	1.69	0.30	0.06	0.29	0.35	1.15
Svenson	0.45	0.10	0.50	0.00	1.90	0.15	0.00	0.38	0.48	1.89
Pontual	0.36	0.71	0.00	0.00	2.65	0.27	0.13	0.34	0.28	0.85
Mean	*0.42*	*0.47*	*0.18*	*0.01*	*2.08*	*0.26*	*0.10*	*0.35*	*0.30*	*1.20*

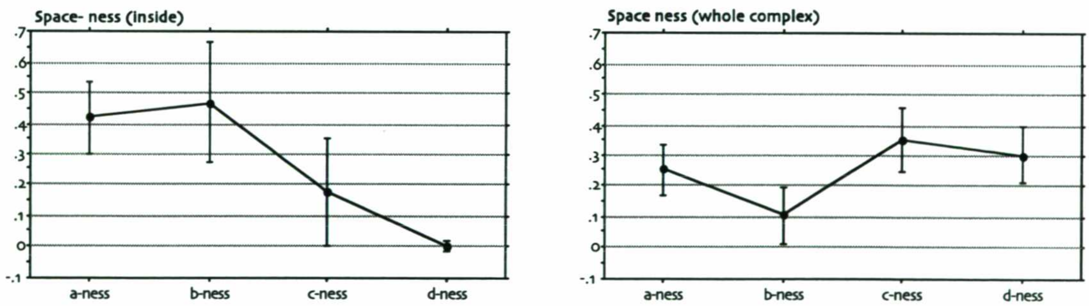

Figure 2.37. Space-ness values: a) inside, b) whole complex

If, on average, the houses present themselves as tree-like systems, indoors, and ringy when the outside is included as a complex, each house present its on particular 'space-ness' profile (figures 2.38. and 2.39., and table 2.4.). These profiles are produced by plotting the space-ness values of each graph, and their classification is done by assessing the inequalities amongst the space-ness values. For example, a 'sinusoid' profile is expressed by a- and c-ness values higher than b- and d-ness values.

Table 2.4. Space-type profiles

Whole complex					**Indoors**				
Profiles	inequalities	cases	% sample	MDV	Profiles	inequalities	cases	% sample	MDV
sinusoid	a>b<c>d	4	50.00	1.32	inverted v-shape	a<b>c≥d	4	50.00	2.29
v-shape	a>b<c≤d	3	37.50	1.31	linear	a≥b≥c≥d	2	25.00	1.57
linear	a≥b≥c≥d	1	12.50	0.41	sinusoid	a>b<c>d	1	12.50	1.9
					L-shape	a>b>c=d	1	12.50	2.43

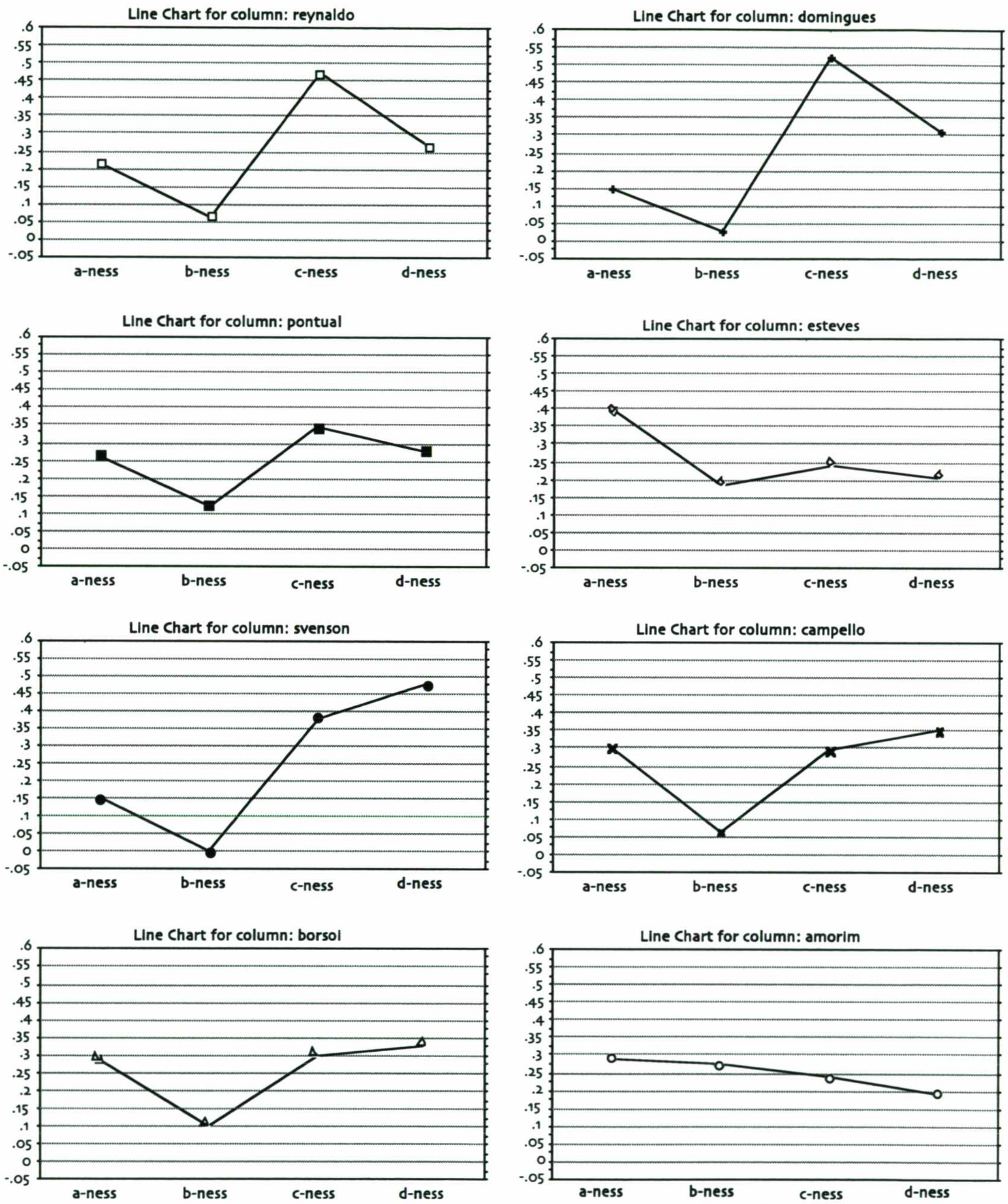

Figure 2.38. Space-ness profiles: the whole complex

Some similarities and inequalities may be spotted immediately. When the outside is included, Reynaldo, Domingues, Esteves and Pontual houses have a 'sinusoid' profile, with high a- and c-ness values and low b- and d-ness values; Borsoi, Campello and Svenson, have a 'v-shape' profile, with low b-ness value; and Amorim house has a 'linear' profile, with a more even distribution of space-ness values. All houses are characterised by a relatively high a-ness and low b-ness values, apart from Amorim and Esteves houses, which have the highest b-ness values of the sample.

The profiles can be compared by the degree of differentiation of the space-ness values. The differentiation amongst values is expressed in syntactic analysis by the difference factor (Hillier, Hanson et al., 1987: 365). Its equation however does not account for differentiation amongst values when 0.00 is included. The *difference value* (DV) is an alternative measure which is applicable to any set of numbers, including 0. It expresses the ratio between the sum of the differences between values, over the average of these values:

$$DV = \frac{\{[n-(n-1)]...+(c-b)+(b-a)\}}{\left\{\frac{[n-(n-1)]+...+c+b+a)}{n}\right\}} \qquad [8]$$

The difference value ranges from 0, no differentiation, to 4, maximum differentiation. Values below 1 show low differentiation; whereas values above 1, describes high differentiation. The lower the value, the more linear and horizontal the profile would be. The higher the value, the more irregular or vertical the profile would be. The average DV for the sample is 1.20. The minimum value is 0.410, for the 'linear' Amorim House, and the maximum is 1.986, for Domingues House.

These profiles are deeply altered without the outside space, yet with the absolute reduction of c- and d-space types and the increase of a- and b-space types. The houses may be arranged in pairs. Amorim and Reynaldo houses become inverted 'v-shape', with high b-ness values and similar a- and c-ness values. A similar profile is seen in Domingues and Pontual houses, however distinguished by the absence of rings in the houses. They have the highest b-ness values of the sample. Borsoi and Campello houses are linear, but more differentiated than Amorim's outside linear profile. Esteves House presents an 'L-shape' format with high a-ness value. Finally, Svenson House alters high a- and c-ness values with low b- and d-ness values (sinusoid profile). The houses also become more differentiated without the outside spaces, because of the low c- and d-ness values. The average difference value become 2.077. The lowest values are for the 'linear' Borsoi (1.458) and Campello (1.690) houses, whereas the highest values, and are for the inverted v-shaped Domingues (2.651) and Pontual (2.628) houses.

The importance of the space type profiles is that it illustrates the likelihood of the spatial composition of the houses, otherwise invisible via the observation of the space-ness values themselves. However, the profiles do not contain any space-use information. They only describe how architects make use of the different types of space to configure the dwelling. In this sense, likelihood between houses does not indicate if key functions are similarly assigned to certain types of space and, therefore, what can be assessed from these profiles is the topological composition of the house. The assessment of space function patterns is better given by their integration pattern.

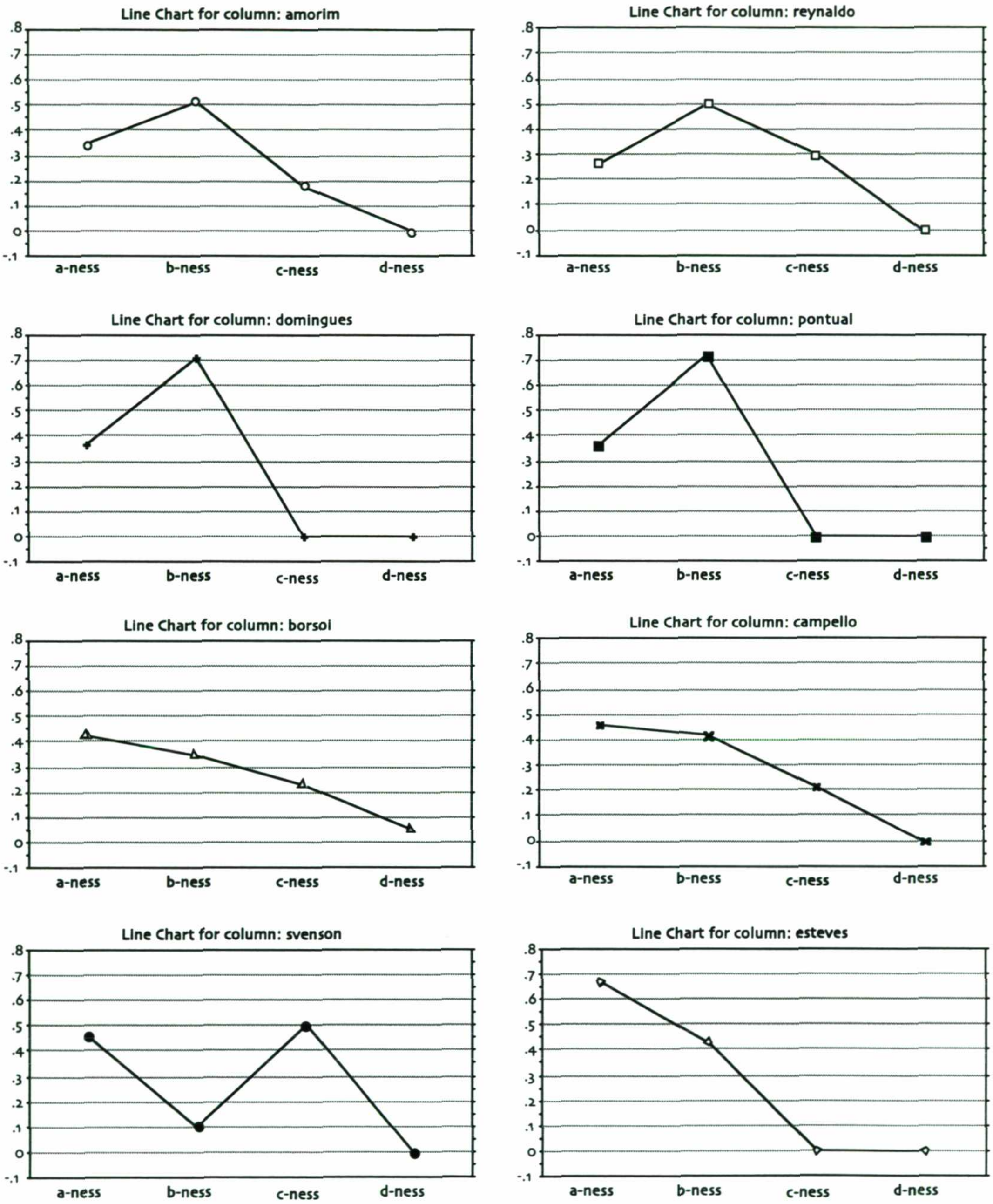

Figure 2.39. Space-ness profiles: indoors

2.5.2. The pattern of integration

2.5.2.1. Mean values

The mean integration value for the architects' Recife houses is 1.570, for the indoor spaces, and 1.350, for indoor and outdoor complexes. Svenson House is the most integrated house in both versions (1.042 and 0.884, respectively), whereas Pontual (1.926) and Amorim (1.566) are the least integrated with regards to the house and to the whole complex, respectively. Amorim, Borsoi and Campello houses are more segregated than the average, both indoors and as a whole complex. Reynaldo and Domingues are more segregated than the average, when their indoor complex is considered, whereas Esteves is less integrated with the outside complex. Architects' houses are substantially outwards oriented, being more integrated with the outside complex. This confirms numerically the acknowledged intense use of outdoor spaces in Brazilian dwellings. Esteves and Campello houses, however, are more integrated on their own. The concentration of integration in Campello's internal patio, contrasting with the segregation of its service spaces, seems to explain the segregation of the house when the outside complex is included.

The value of visual integration presents a similar pattern. The average value for the indoor complex is 0.492, whereas for the whole complex is 0.278. These values confirm the role of the outdoor complex in making the whole system shallow. Visual integration is increased with the outside because visual links between indoor spaces are formed through the gardens. Amorim House is the most visually integrated house (0.242) with the outdoor complex. This is caused by the ''surveillance effect' of the roof gardens, and also by the size and shape of the outside spaces, allowing extensive visual fields, both horizontal and vertical. When the indoor complex is isolated, Domingues House becomes the most integrated dwelling (0.340), due to the thoroughfare plan.

2.5.2.2. Cognitive values

The cognitive value of the houses when seen as a whole complex ranges from 0.109 (Amorim House) to 0.555 (Domingues House), with an average of 0.296. The isolation of the indoor spaces give higher cognition values, ranging from 0.374 (Svenson House) to 0.779 (Pontual House), with an average of 0.588. This result poses a paradox, which shall be called the 'cognitive paradox'. The dwellings are visually more integrated when the outside is included, but they tend to be less intelligible. Integration is increased because the connectivity of the system is higher, making all spaces shallower from each other. However, the reduction in visual depth does not correlate to the accessibility pattern of the houses, therefore spaces which are highly accessible from the point of view of accessibility are visually inaccessible. This is clearly seen in Amorim House, the most visually integrated house, but the least cognitional of all.

Some houses announce solutions for this paradox. Domingues house is the only house in the sample to have a higher cognition value when the outdoor complex is included (0.555). This is because the spaces which compose the internal patio, mostly the terraces, enhance both accessibility and visibility of the spaces, previously deeply situated at the end of the wings, but also because the spaces situated at the periphery of the social-private complex are similarly affected. Borsoi House follows Domingues House in the order of the cognitive value for the whole complex. Although weaker than the value for the building itself, the house maintains a relatively high value (0.532). It does so by keeping the integration core of the house stable when introducing the outside spaces and concomitantly, proportionally extending its visual fields. The transparency of the central void, both indoors and outdoors, is one of the mechanisms used to keep the visual links more or less stable when the outside spaces are added.

2.5.2.3. Rank order of integration

The hub of integration of the interior of these two houses is located at transitional spaces, but in Borsoi House the office is as integrated as the ramp, the mediator between social and private zones. In fact, the mediator space is the most integrated space in five houses, being also the second in order of integration in Amorim and Esteves houses. This suggests that the way the houses are sectored and joined together by means of mediators may be of fundamental importance in distributing integration in the houses. The inclusion of the outside complex alters this pattern by concentrating integration in functional spaces in Borsoi, Domingues, Campello and Pontual houses. Mediation, however remains a powerful instrument to concentrate integration in Reynaldo, Esteves, Domingues and Svenson houses, but also in Amorim and Campello houses, in which the mediator space is the second and third in the order of integration, respectively. This fundamental problem is fully addressed in chapter seven.

The pattern of integration can now be analysed by the rank order of integration of the main daytime domestic activities - receiving (R), eating (E) and cooking (C), according to the procedures standardised by Hillier, Hanson and Grahan (1987), and by observing how these activities are ordered with and without the outside system (table 2.5.). In the indoor system the order $E<R<C$ is the most popular, with 3 occurrences, followed by $R<E<C$ and $E<C<R$ with two citations. The order $E=R<C$ is only found in Svenson house as eating and receiving are compressed in a single convex space.

Table 2.5. Rank order of integration of domestic activities

Houses	Order basic activities		Order extended activities	
	inside	comple	inside	complex
Amorim	E<R<C	E<R<C	E<R<S<C<W	E<R<C<W<S
Reynaldo	E<R<C	E<R<C	E<R<S<C<W	E<R<S<C<W
Borsoi	R<E<C	R<E<C	W<R<E<S<C	R<E<W,C<S
Esteves	E<C<R	C<E<R	S<E<C<R	C<E<R<S
Domingues	E<C<R	E<R<C	S<E<C<R<W	E<R<C<S<W
Campello	E<R<C	E<C<R	E<R=S<C<W	E<C<R<W<S
Svenson	E=R<C	E=R<C	E=R<S<C	E=R<S<C
Pontual	R<E<C	R<C<E	R<E<W<C<S	R<C<E<W<S
overall	E<R<C	E<R<C	E<R<S<C<W	E<R<C<S<W

With the introduction of the outdoor system, the order *E<R<C* remains as popular as before, with three citations, but the remaining cases are individually ordered. Some houses keep the rank order stable with and without the outside spaces. Amorim and Reynaldo houses preserve the rank order *E<R<C*, whereas Borsoi and Svenson houses keep the orders *R<E<C* and *E=R<C* intact. The remaining houses reshuffle the order of integration by integrating cooking and/or segregating receiving activities.

Nevertheless, in the variations in the order of integration, eating remains the most integrating daily activity in six cases, without the outside spaces, and in five when they are included. The exclusion of Amorim House, designed for other cultural environment, does not alter the eating-centred profile of the sample. It is known that there are thirteen possible arrangements of the domestic main functions, and the consistency of this result is remarkable in such a small sample. The overall genotype, generated by ranking order the mean values for each activity (figure 2.40.) confirms the pervasiveness of the inequality *E<R<C*, in both system (inside and the whole complex).

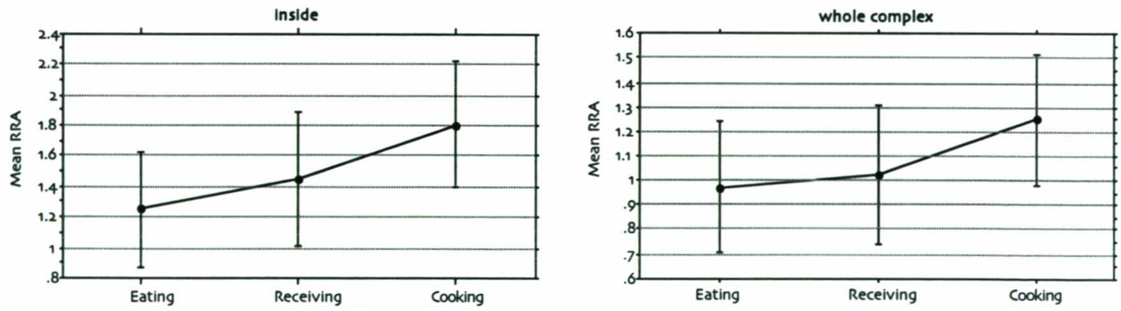

Figure 2.40. Order of integration of basic domestic activities

But this result does not cause surprise when it is considered that eating-centred houses are the most common type of domestic configuration of Recife historical houses (Trigueiro, 1994: pp 293-296). Indeed, one of the main findings of Trigueiro's study of colonial and eclectic houses of Recife, is the sheer predominance of eating integrated houses, particularly amongst the latter. These evidences point towards a continuous cultural line from colonial to modern dwellings.

However, if there is a genotypical form in these houses, it is extremely weak. The difference factor (DF) for the whole complex ranges from 0.928, in Borsoi House, to 1.000, no differentiation, in Pontual House. The average for the sample, 0.976, does not include Svenson House because living and dining are compressed in the same convex space. If the outdoor spaces are disregarded the DF does not suffer major alterations. The maximum differentiation is found again in Borsoi House, 0.904, and minimum value in Domingues House, 0.990, with an average of 0.958 for the sample. These values show how undifferentiated the main domestic activities are; possibly because integration is dragged by transitional spaces, positioning these key spaces in rather similar ranks of the integration pattern.

It is also possible that the triad receiving-eating-cooking does not correspond to the way these houses were supposed to be spatially differentiated. Indeed, modern houses have a higher degree of informality in receiving and dining, blurring the isolation of one space to the other. As domestic environment endures a range of other activities, it is tempting to look at how other occupations are ordered. Even though it is known that the higher the number of activities observed, the less the chance of finding consistent ordered patterns, because the possible combination of activities is multiplied, nevertheless, sleeping, identified by the integration value of the main bedroom, and working are ranked with the main daily activities (table 2.5.).

The overall genotypical order of the extended domestic activities is presented in figure 2.41. For the inside system, the inequality $E<R<S<C<W$ confirms the importance of eating and receiving in the household, but is significant that sleeping is on average more integrated than cooking and working. This inequality is slightly changed with the introduction of the outside complex. Cooking becomes more integrated, moving to the position previously occupied by sleeping ($E<R<C<S<W$). It seems that when the house is opened to allow the circulation of servants in the household, the private rooms are detached from the hub of integration, reassuring the necessary seclusion for the inhabitants.

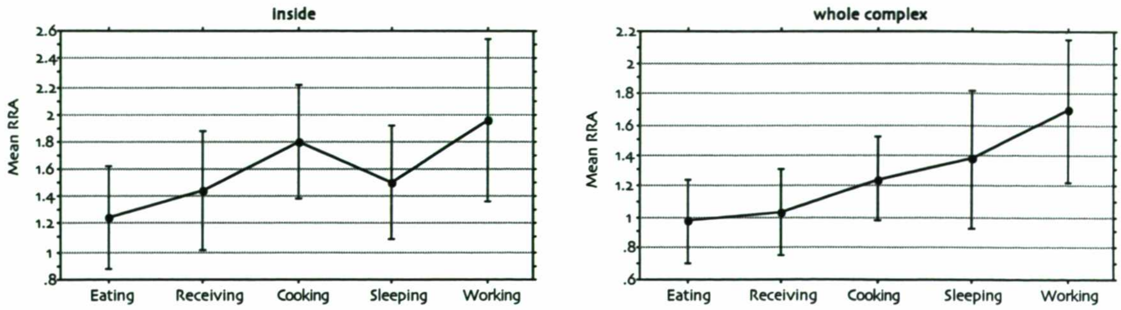

Figure 2.41. Order of integration of extended domestic activities

Two houses, Amorim and Reynaldo, present the same indoors order of integration of the extended domestic activities. Reynaldo and Svenson houses keep the order unaltered with and without the outside spaces. These results are quite remarkable, considering the probabilistic chance to find equal arrangements in a sample of this size.

The position of working and sleeping activities are also of interest. When the houses are isolated from the outside, offices tend to occupy the most segregated position, but in Borsoi House it is the most integrated space. In Amorim and Campello houses, when the outdoor spaces are introduced, working spaces become more integrated, replacing the main bedroom in the rank order of integration. In the other houses, working either keeps its position stable, or becomes even more segregated. However it is interesting to note that in Borsoi House, after receiving and eating spaces, the office remains the centre of integration.

The position of the office seems to depend on architects' interest in deciding to integrate, or to segregate, professional activities with family life. For example, Amorim House segregates the office because it was intended to be his professional workplace. His office is placed in an isolated branch, accessible from the vestibule: shallow from the outside, but configurationally deep. Segregation here means isolation of the client from the domestic environment. Domingues and Pontual are eyrie models, deeply positioned in the private sector. Reynaldo and Campello, are 'receiving models'; however, Campello's is more likely to be a living space, rather than a working studio. The most distinctive case is Borsoi's office. It is neither deep or segregated, but accessible to visitors and integrated. In fact, the studio is strategically located in the integration core of the building, part of visitors' entertainment rooms.

There are some odd cases amongst these houses. Firstly, Esteves House integrates sleeping activities and segregates receiving ones, indoors. This is changed when the outside complex is included, receiving remaining segregated and cooking becoming the most integrated activity. This is caused by the strategic position of the kitchen in connecting the social and service zones. Campello House also integrates cooking when the whole complex is analysed, combining space flow and space integration to qualify space use.

The fact that social activities tend to be more integrated than service and private ones and the persistency by which mediator spaces are found in the configurational core of the houses, may be an effect of houses' sectors' organisation. A closer look at the sectors' arrangements of the dwellings may shed some light on this question.

2.5.3. The sectors' analysis

The first aspect to be mentioned about the sectors' organisation is the sheer variety of types. Each house is organised into sectors, but in particular manners, differing in the number of nodes and in the configuration itself (figure 2.42.). The individuality in which the houses are sectored suggests that, however submitted to the paradigm of sectors, architects do explore the potentialities of space organisation. The following sections scrutinise the configurational properties of the sectors' graphs. Firstly, their topological sizes are counted; secondly, the occurrence of space types per sector is described; thirdly, the relative depth of each sector from the exterior is monitored; and finally the integration pattern of the arrangements is calculated. Table 2.6. resumes the data.

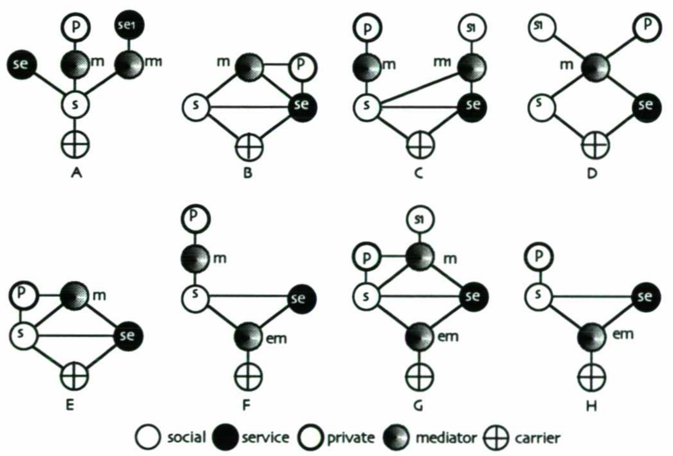

Figure 2.42. The sectors' graphs

Table 2.6. The sectors' analysis

Houses				Social			Social 1			Service			Service 1			Private			Mediator			Mediator1			Ext. Med.			Exterior		
	T	S	MRRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA
Amorim	A	7	1.290	b	1	0.393				a	3	1.963	a	2	1.374	a	3	1.963	b	2	0.981	b	2	0.981				a	0	1.374
Reynaldo	B	5	0.568	d	1	0.473				d	1	0.000				c	2	0.946	d	2	0.473							c	0	0.946
Borsoi	C	7	1.121	d	1	0.392	a	3	1.77	d	1	0.785				a	3	1.962	b	2	0.981	c	2	0.785				c	0	1.177
Esteves	D	6	1.050	c	1	0.859	a	3	1.43	c	1	0.859				a	3	1.432	c	2	0.286							c	0	1.432
Domingues	E	5	0.568	d	1	0.000				d	1	0.473				c	2	0.946	d	2	0.473							c	0	0.946
Campello	F	6	1.34	c	2	0.57				c	2	1.15				a	4	2.29	b	3	1.15				c	1	0.859	a	0	2.005
Svenson	G	7	0.953	d	2	0.392	a	4	1.570	d	2	0.588				c	3	0.981	d	3	0.588				c	1	0.785	a	0	1.766
Pontual	H	5	1.136	c	2	0.473				c	2	0.946				a	3	1.893							c	1	0.47	a	0	1.893

T=type; S=size; st= space type; d= depth from the exterior; MRRA= mean RRA of the graph

2.5.3.1. Topological size

The graphs vary from five to seven nodes. Amorim, Borsoi and Svenson houses are the most complex ones. This denotes that size of the graphs does not correlate with the size of the house (geometrically and topologically speaking) nor with the number of storeys (figure 2.43.). The complexity of the sectors' graph is a function of architects' requirements, for example, by introducing two mediator and secondary sectors, in Borsoi and Amorim houses, or secondary sectors in Svenson and Esteves houses. Pontual House has the simplest structure, but adds an external mediator, in order to isolate formal and informal accesses, at the main entrance.

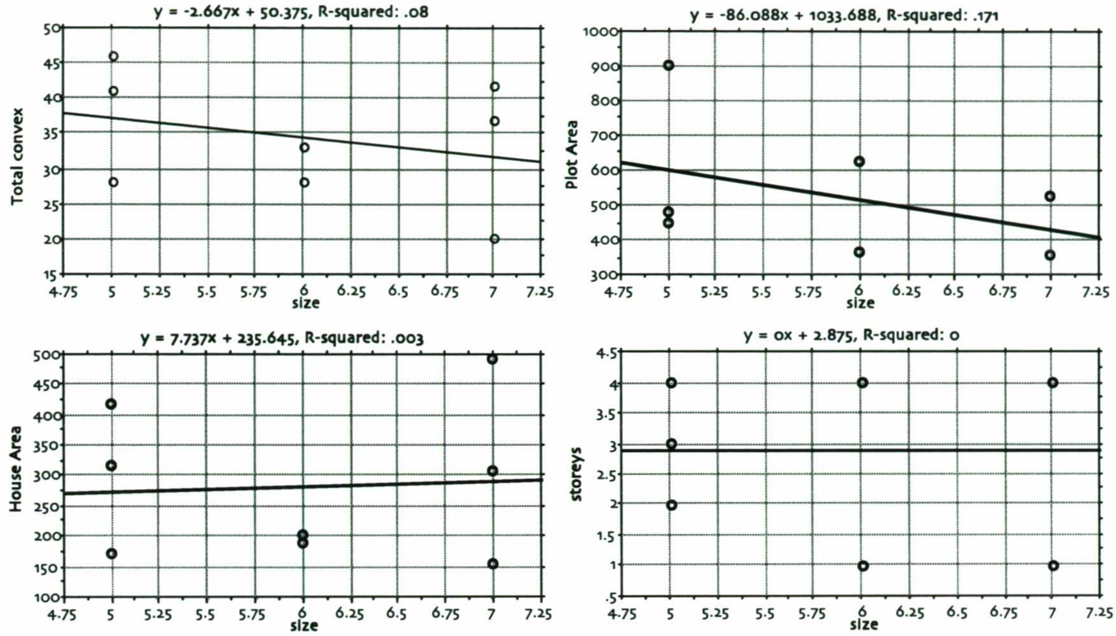

Figure 2.43. Graphs' size: geometrical and topological correlations

2.5.3.2. *Space type*

The second evaluation looks at the occurrence of space types per sector. This suggests which role sectors have in configuring the house. Figure 2.44. presents the sectors' graphs labelled according to their space types, and table 2.7. resumes the data.

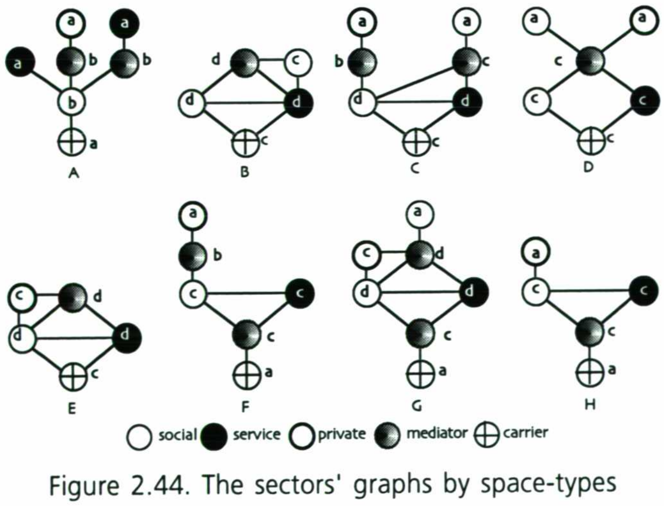

Figure 2.44. The sectors' graphs by space-types

Table 2.7. Space-type per sector

Space type	social		social 1		service		service 1		private		mediator		mediator 1		ext. med.		exterior	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
a	0	0.00	3	100.00	1	12.50	1	100.00	5	62.50	0	0.00	0	0.00	0	0.00	4	50.00
b	1	12.50	0	0.00	0	0.00	0	0.00	0	0.00	3	42.86	1	50.00	0	0.00	0	0.00
c	3	37.50	0	0.00	3	37.50	0	0.00	3	37.50	1	14.29	1	50.00	1	100.00	4	50.00
d	4	50.00	0	0.00	4	50.00	0	0.00	0	0.00	3	42.86	0	0.00	0	0.00	0	0.00
Total	*8*		*3*		*8*		*1*		*8*		*7*		*2*		*1*		*8*	

Social and service sectors are similarly found in the graphs. When the social sector is included in a ring, so is the service sector. When the social sector assumes a c- or d-type space, the service sector occupies the same position as well. They only differ in Amorim House, where the service sector assumes an a-type position, only accessible through the b-type social sector. In fact, Amorim House is an exception in many circumstances. For example, it is the only tree-like system and the only one to isolate the outside service spaces from the indoor ones. Perhaps the distinctiveness of Amorim House has to do with the cultural environment it was designed for, or most probably, with the experimental nature of its design.

The private and public spaces have also assumed similar positions in the graphs. They are a- and c-type spaces. The private sector is included in a ring in three occasions, when optional access is offered either from the social or the service sectors. Otherwise, it is isolated as a deep a-type node. The public realm is an a-type space when an external mediator is used, isolating the dwelling from the street, or when the access to the service sector is controlled by the social one (Amorim House). In the remaining cases, the exterior is situated in a ring with visitors and servants entrances. Finally, the mediator sector appears in three modes, mostly as a b-type space (4 cases) maximising depth and isolating the private sector; as a d-type space, in Reynaldo and Svenson houses, offering higher choices of movement through the household; and finally as a c-type space, in Domingues house.

Table 2.8. shows the degrees of space-ness of the sectors' graphs and figure 2.45. shows the space-type profile of each house. Reynaldo and Domingues sectors' graphs are symmetrical, therefore, present the same 'j-shape' profile. Amorim's 'L-shaped' graph mirrors the previous ones with high a- and b-ness values. These three graphs have the highest DV of the sample (2.400 and 2.499). Esteves, Pontual and Campello have 'sinusoid' profiles, whereas Borsoi and Svenson houses are 'v-shaped'. Despite the diversity of houses' profiles the substantial degree of c- and a-ness throughout the sectors' graphs is clear. Within the range of space-ness values, the typical order of occurrence is *b<d<a<c* (figure 2.46.).

Table 2.8. Space-ness values

House	type	a-ness	b-ness	c-ness	d-ness	DV
Amorim	A	0.67	0.40	0.00	0.00	2.50
Reynaldo	B	0.00	0.00	0.40	0.60	2.40
Borsoi	C	0.33	0.20	0.29	0.29	0.48
Esteves	D	0.40	0.00	0.67	0.00	2.50
Domingues	E	0.00	0.00	0.40	0.60	2.40
Campello	F	0.40	0.25	0.50	0.00	1.74
Svenson	G	0.33	0.00	0.29	0.43	1.64
Pontual	H	0.50	0.00	0.60	0.00	2.18
Mean		0.33	0.11	0.39	0.24	1.98

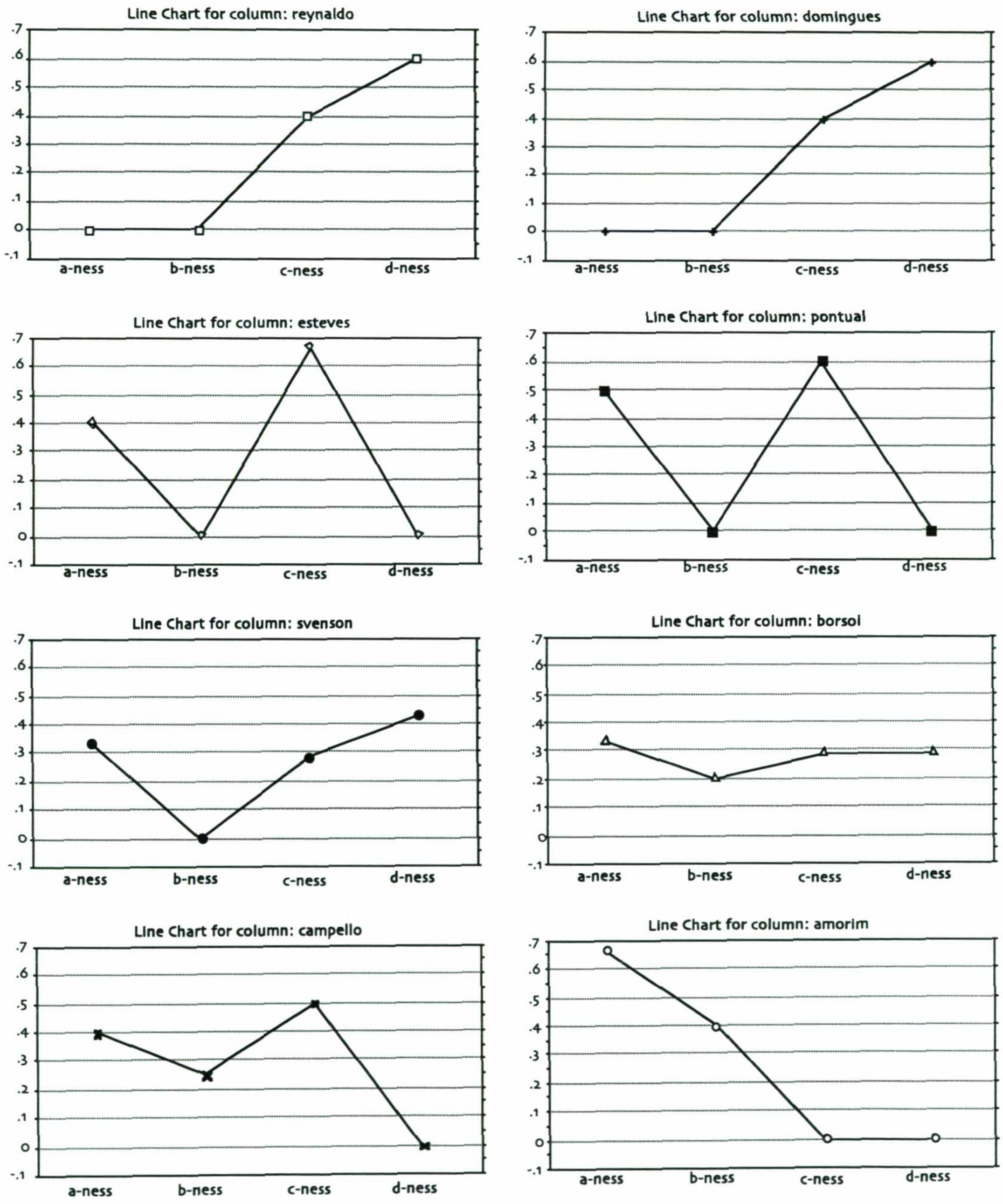

Figure 2.45. The sectors' space-type profiles

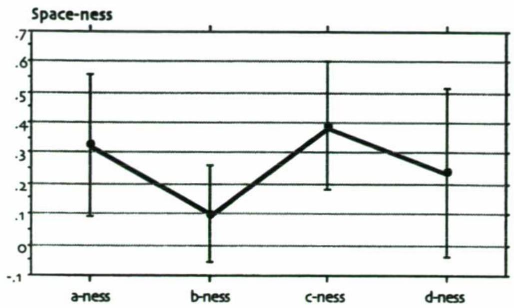

Figure 2.46. The genotypical order of sectors' space-ness values

2.5.3.3. *Depth from the exterior*

Figure 2.47. plots the depth from the exterior of the main functional sectors (social, service and private) and the internal mediator in each house in one graph, and also isolates the secondary ones in a separate graph. Important consistencies are found. The social and service sectors are always the shallowest sectors from the street, unless, for obvious reasons, when an external mediator is introduced. In these cases these sectors become two steps away from the street, but even so, they continue to be shallower than the remaining sectors. The only exception is Amorim House, where the service is one step deeper than the social sector. The private sector is always the deepest sector of all, or amongst the deepest ones. It becomes shallower when it is connected to the mediator and to the social or service sectors. In Pontual House, the absence of a mediator unit gives direct access to the bedrooms from the social area, not seen otherwise in the sample. The mediator sector stays one step deeper from social and service sectors, isolating the private zone. Social and mediator sectors are always one step deeper from each other, suggesting that introducing the mediator sector has the main role to isolate, as a buffer zone, the privacy of the family, from the spaces for receiving guests. The secondary sectors reproduce most of the characteristics of their related main sectors, with the exception of the social sector 1 which is deeper than the social one in every case.

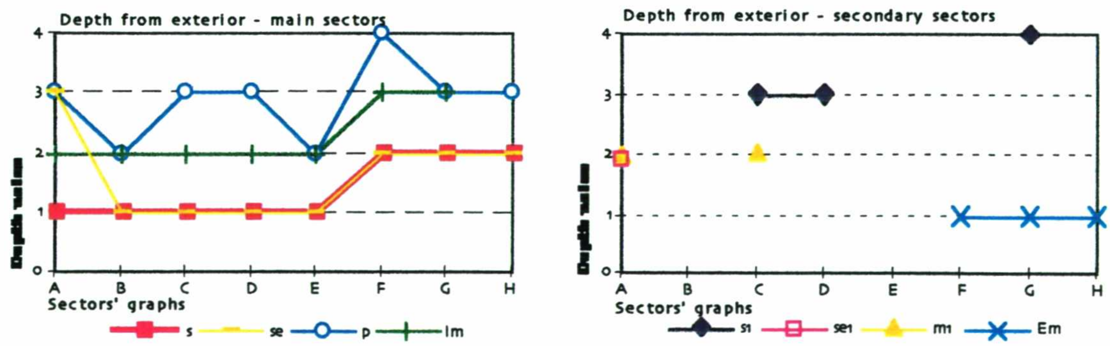

Figure 2.47. Depth from exterior: main and secondary sectors

2.5.3.4. Integration analysis

The final clue for the understanding of the sectors' arrangements is given by the integration analysis. Table 2.9., sums up the values by sector in each arrangement and rank them in order of integration, from the most integrated (low RRA values) to the most segregated (high RRA values). Figure 2.48 shows the distribution of integration amongst the main sectors and figure 2.49. presents their overall genotypical order of integration.

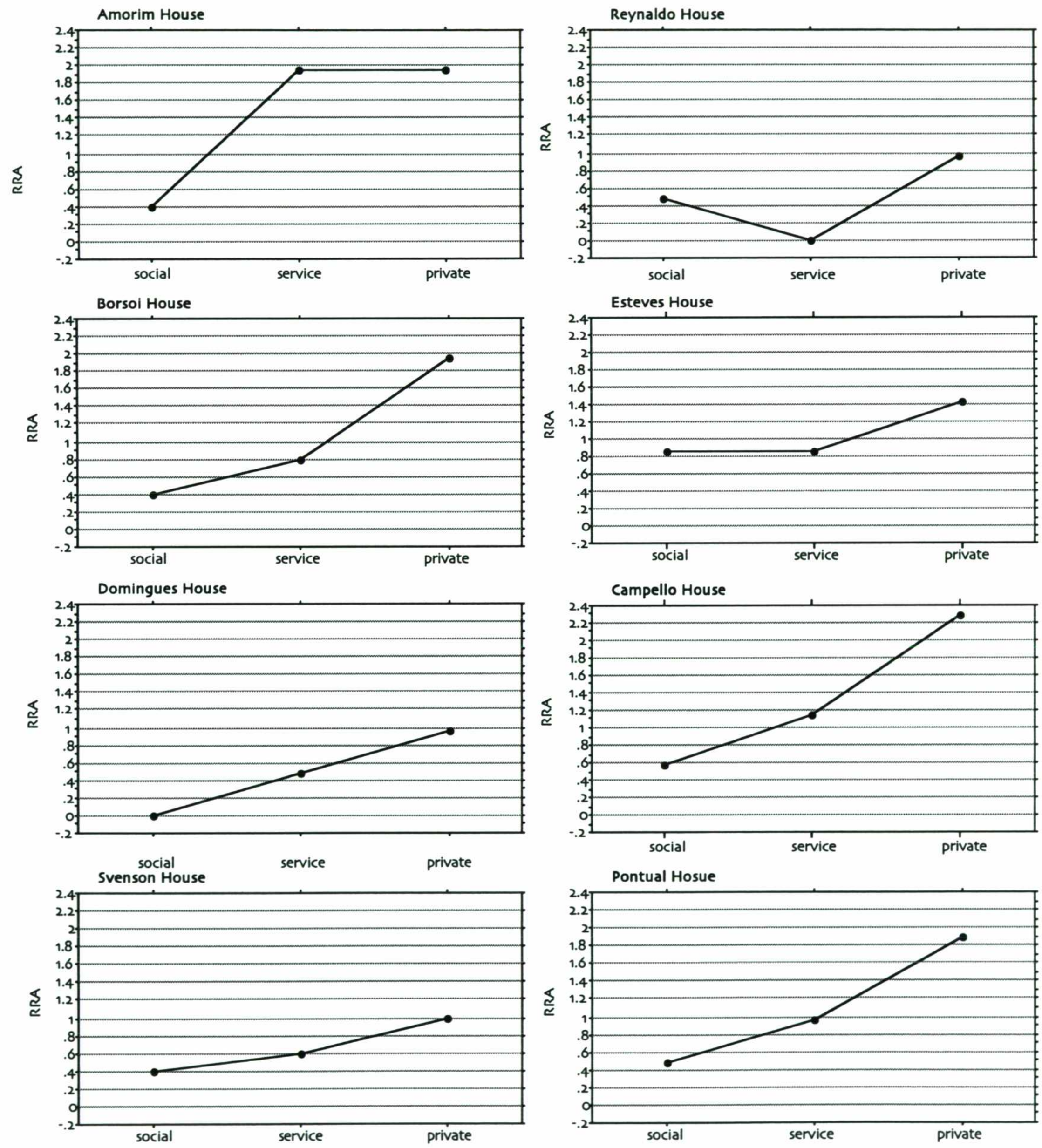

Figure 2.48. Order of integration of the main sectors per house

Table 2.9. Rank order of integration of the sectors

Rank Order of RRA - All sectors								**Rank Order of RRA - Main sectors**				
Types	s	m	m1	se1	e	se	p	Types	s	se	p	DV
A	0.393	< 0.981	= 0.981	< 1.374	= 1.374	< 1.963	= 1.963	**A**	0.393	< 1.963	= 1.963	1.09
	se	s	m	p	e				se	s	p	
B	0.000	< 0.473	= 0.473	< 0.946	= 0.946			**B**	0.000	< 0.473	< 0.946	2.00
	s	se	m1	m	e	s1	p		s	se	p	
C	0.392	< 0.785	= 0.785	< 0.981	< 1.177	< 1.766	< 1.962	**C**	0.392	< 0.785	< 1.962	1.50
	m	s	se	s1	p	e			s	se	p	
D	0.286	< 0.859	= 0.859	< 1.432	= 1.432	= 1.432		**D**	0.859	= 0.859	< 1.432	0.55
	s	se	m	p	e				s	se	p	
E	0.000	< 0.473	= 0.473	< 0.946	= 0.946			**E**	0.000	< 0.473	< 0.946	2.00
	s	em	se	m	e	p			s	se	p	
F	0.573	< 0.859	< 1.146	= 1.146	< 2.005	< 2.292		**F**	0.573	< 1.146	< 2.292	1.29
	s	se	m	em	p	s1	e		s	se	p	
G	0.392	< 0.588	= 0.588	< 0.785	< 0.981	< 1.570	< 1.766	**G**	0.392	< 0.588	< 0.981	0.90
	s	em	se	p	e				s	se	p	
H	0.473	= 0.473	< 0.946	< 1.893	= 1.893			**H**	0.473	< 0.946	< 1.893	1.29

s=social; s1=social 1; se=service; se1=service 1; p=private; m=mediator; m1=mediator 1; em=external mediator; e=exterior

The first aspect to be noted is the presence of the social and service sectors at the highest spectrum of integration, particularly the social sector, which is the most integrated node in six out of eight cases. The mediator sector is also present at the lowest band of integration, but mostly at its medium. On the opposite side of the rank are the private and public realms, always the most segregated nodes of the graphs.

When the social, service and private sectors (the sectors present in all graphs) are isolated, the ranking order presents a surprising result (table 2.10). The order of integration *s<se<p* is present in five cases, followed by the sequences *s<se=p*, *se<s=p*, and *s=se<p*, with one citation each. The pattern *s=se<p*, found in Esteves House, is the weakest of all (0.546); whereas the remaining patterns are substantially differentiated, with values above 1. The mean difference value for the order *s<se<p* is 1.395, ranging from 0.901 (Svenson House) to 2.000 (Domingues House). This result confirms the consistency of this pattern.

Table 2.10. The sectors' genotypes

Genotype a (s<se<p)			**Genotype b (se<s<p)**			**Genotype c (s=se<p)**			**Genotype d (s<se=p)**		
types	MRRA	DV	types	MRRA	DV	types	MRRA	DV	types	MRRA	DV
C	1.290	1.09	B	0.568	2.00	C	1.121	0.55	A	1.290	1.09
E	0.568	2.00									
F	1.337	1.29									
G	0.953	0.90									
H	1.136	1.29									
Mean	*1.057*	*1.313*		*0.568*	*2.00*		*1.121*	*0.55*		1.290	*1.09*

The number of occurrences and the strength of the pattern *s<se<p*, suggest the existence of a genotypical form of sectors' configuration, which is confirmed by the average RRA value for the sectors as seen in figure 2. 49. It integrates social activities, segregates the family realm and operates the service activities to attend the demands of the social and private needs. The limited size of the sample does not statistically support the argument of a genotypical

form of sectors' organisation in Recife's modern dwellings, but this might well be the case. It seems that the sectors' arrangements are genotypically composed, regardless of the form they may take. If genotypical forms are present in a larger sample, then a fundamental concept in space syntax field, which suggests that architects' houses do not follow functional genotype of ends, could be considered.

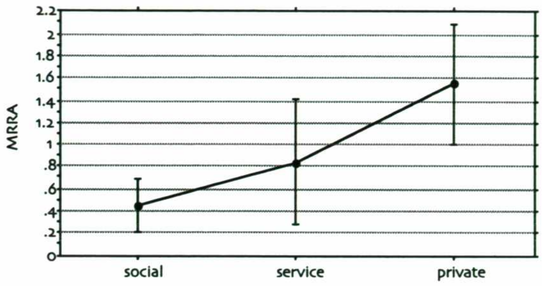

Figure 2.49. Overall genotypical order of integration of the main sectors

2.6. On some findings and questions

This chapter aims at answering the question of how the paradigmatic idea of domestic sectors manifest themselves in Recife architects' houses. It has described the spatial nature of the architects' houses by applying space syntax techniques. It has shown, with the use of the methodological innovation of the sectors' analysis, that their houses are not only functionally zoned, but consistently configured, regardless of the individuality of each house, which, both spatially and functionally is very high.

The social sector has tended to be the shallowest and most integrated node, being mostly included in a ring, either as a c- or a d-type space. The service sector tends to follow the social sector in order of integration, it is included in the same ring with the social sector, and it is either c- or d-type spaces. The private sector and the exterior are always the most segregated nodes, being a- or c-type spaces. Finally, the mediator sector isolates the private sector, being mostly a b-type space. The consistency of the sectors' arrangement is represented by the inequality genotype *s<se<p*, in spite of the presence of the complex outside in the analysis. This underlying consistency by which the sectors are ordered suggests that, regardless of the form the sectors' arrangement may take, some genotypical forms do emerge. The sheer prevalence of the model *s<se<p* over the others is a sign that this is the case. Would this genotype be prevalent in a larger sample of modern houses? Would genotypical arrangements be found only in architects' houses?

However, the space-by-space analysis showed some interesting correlations between the sectors' organisation and the pattern of integration of their component spaces. The spaces for the private use of the inhabitants preserve similar properties amongst them. They are separated from the rest of the house, being mostly dead-end spaces, and when not, just trivial rings are to be found. There are however some interesting exceptions. Domingues and Svenson houses open the private rooms to the outside, introducing local and global rings to the private zone. Would the openness of the bedrooms be just a tendency towards individuation? Would it be a characteristic of houses designed by architects?

If the configuration of the private spaces vary, the service rooms seem to be more consistently organised amongst the houses. The servants' premises are mostly organised in outbuildings, extending a long lasting tradition in shaping domestic buildings of Recife which has its origins in the slaves' accomodation of the Colonial and Imperial dwellings (1500-1822 and 1822-1889). They are also visually isolated and more segregated than functional social spaces.[21] Would this isolation of the servants quarters be extensively found? Would it be a form of spatially represented social status in the house? If so, would this be an indicator of the architect's submission to cultural values? The unusualness of Amorim house in keeping servants' quarters inside the house, indicates that this might well be the case.

The transitional elements were extensively used as buffer zones, preventing the interference of one sector over the other, but essentially segregating household members. This mediator sector contributed for reducing the potential co-presence of servants, inhabitants and visitors in the same space when it was not desirable. Is this a common concern amongst Recife's architects? Is this segregation essential for a better functioning of the house?

The space-by-space analysis pointed out an interesting coincidence between the distribution of integration and the sectors' arrangements. When a mediator sector is used, integration tend to be distributed around it, fading away towards the private and service sectors. When mediation is absent or when double mediation is applied, its power in drawing integration weakens because accessibility amongst the sectors is less controlled. Would there be any direct relationship between the organisation of the sectors and the space-by-space pattern of integration? If yes, how does it work?

The questions which comes next is whether this phenomenon is restricted to the architects' houses, as prototypes of designers' ideologies, in other words,

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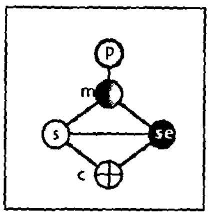
21 The segregation of the service spaces, and therefore of servants in the household, has also been observed in studies of the domestic organisation, for example of Mexican (Stea 1995: pp 191) and Australian (Lawrence, 1987: pp 94-106) dwellings.

demonstrating the methods by which the houses were designed and representing an idealised form of domestic organisation. If this is the case, how would the house which architects designed for their clients be organised? Would it follow the same sectoring pattern? Would it be less diagrammatic planned? Or, on the contrary, would it be more diagrammatic, expressing the architects desire to shape new lifestyles? In this hypothesis, would the diagrams be permeated by social and cultural values embedded in clients' (and architects') minds?

The following chapter tries to answer some of these questions. It develops an extensive investigation of the form by which Recife modernist housing is organised into sectors. The chapter extends the research to a much wider sample of 204 dwellings, built between 1930 and 1980. It is aimed that, by adding diversity, the phenomenon itself may be properly identified.

Chapter Three
The Sectors' Paradigm



The diagnostic study of Recife architects' houses, developed in chapter 2, demonstrated individualism and spatial experimentalism, which are fundamental characteristics of this particular type of house. It also showed that, despite their individuality and spatial creativity, they shared the same principle of organising kinds of domestic activities into separate sectors. This paradigmatic idea was manifested in different arrangements without attaining to a specific model or format. This diversity in shaping houses' form was understood as the natural tendency architects have to explore spatial organisations, rather than to replicate typical formats. But more importantly, the previous chapter revealed the existence of a genotypical form of sectoring the houses.

This chapter aims at investigating the question of whether the spatial characteristics found amongst Recife architects' houses are also to be found in a larger and more diverse sample. It is particularly concerned with how houses are sectored and if they manifest any sort of genotypical form. It investigates by identifying and analysing houses' sectors' organisation through the same methodological procedures described in chapter 2, section 2.2. Therefore this chapter is only concerned with the sectors' organisation of the modernist houses of Recife.

This chapter is divided into five sections. The first section (3.1.) characterises the sample, by highlighting its diversity and representativeness. The following section (3.2.) describes the results of the sectors' analysis of a sample of 204 modern dwellings. It deals with extensive configurational analysis of the sectors' graphs, observing their topological size, i.e., the number of nodes in the graph, occurrence of space type per sector, depth from the exterior and integration. The data produced is then discussed in section 3.3. in order to clarify the restrictive rules which oriented the generation of the phenotypical set of sectors' graphs but, more importantly, their genotypical configurations. The following part (section 3.4.) discusses the effect the sectors' paradigm might have on design process. The analysis of the Recife modernist dwellings suggests that the sectors' paradigm reduces the infinite field of architectural possibilities to a finite field where intuition and individual needs can be expressed. The chapter concludes in section 3.5. by observing the prevalence of certain social and cultural codes embedded in the sectors' arrangements. It also raises the hypothesis that the process of sectoring Recife's houses may be rooted in traditional social practices.

3.1. The modernist houses

The collection of houses accurately forms a sample of Recife's modernist housing tradition. Indeed, the sample is diverse in its architectural features and in the number and significance of its designers, as it may be observed through their plans (see laser disk included) and geometrical and syntactic data (see table A.3.1. in Appendix 3).

The designers whose houses were considered for the sample came from different origins, graduated from different schools and developed their particular architectural expressions. European architects, like Mounier, Russo and Amorim, were important in developing a rationalist design practise. Others were trained in different parts of the country, bringing fresh ideas to Recife's limited modernist experience. Architects like Acácio Borsoi, Glauco Campello and Florismundo Lins were trained in Rio de Janeiro. Others, like Frank Svenson, came from Belo Horizonte. But the majority of the designers were educated in Recife, between 1940 and 1970.

The sample includes houses designed by architects, but also by other professionals - draftsmen and engineers - defining a control group. The sample collects ninety three designers - one draftsman (1.07%), eighteen engineers (19.35%), seventy one architects (76.34%) - and three cases (3.22%) in which the submitted plans do not clearly state the professional status of the designer. Architects contribute with one hundred and seventy seven houses, corresponding to 86.76% of the two hundred and four dwellings which compose the sample, whereas engineers contribute with twenty four (10.78%), draftsmen with two (0.98%), and three houses (1.47%) were designed by unidentified professionals. It is possible that several projects submitted for approval under the technical responsibility of architects and engineers were in fact designed by draftsmen or students. Investigating the original copyright of the projects was an impossible task. Thus, the professionals whose signatures are held responsible for these houses' design are assumed to be their authors.

The sample includes one of the earliest modernist housing experiments in the city, designed by French architect Mounier, in 1937. His 'purists' houses (M1 and M2) remained for many years as the most representative examples of the rationalist architecture in the city. The 1940's introduced the 'functionalist house', so publicised by the now established Brazilian modern architecture.

One of the earliest examples of this housing typology is Carvalho House (M3), designed by Hélio Feijó, in 1947 (figure 3.1.).

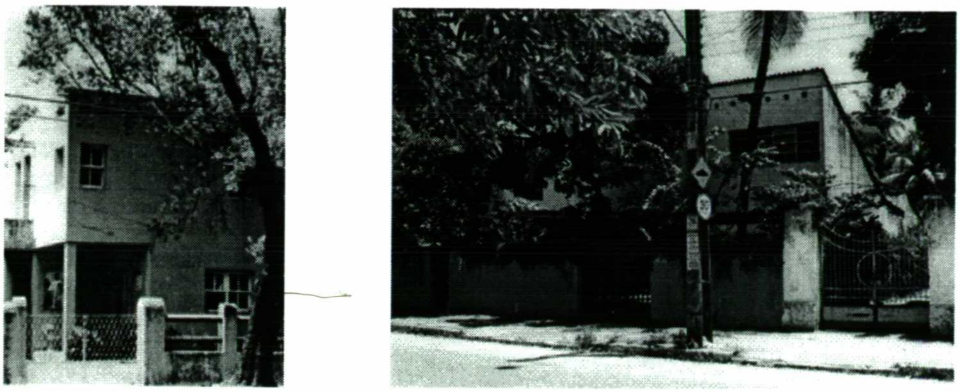
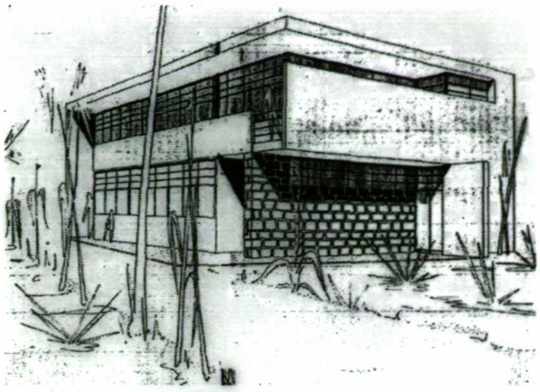


Figure 3.1. Santos (a) and Carvalho (b) houses

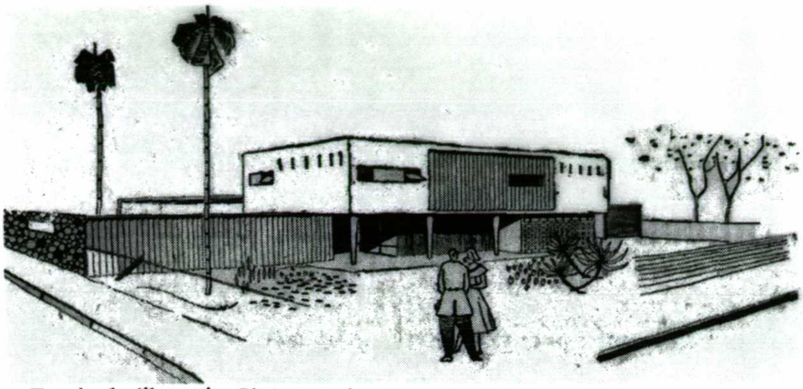
The following decades, 1960 and 1970, are the most diverse in terms of architectural experimentation. The 'functionalist house' is extensively reinvented in an endless variety of solutions, but the 'colonial contemporary' appears as an alternative experimental field, which pervaded most of the 1960's. Figure 3.2. presents the diversity of the modernist experiment in Recife.

The variety in architectural styles is also expressed in the diversity of other architectural features. For example, the sample compiles houses with different levels. The majority of houses have more than one storey (58.82%), but seven (3.43%) have a mezzanine, and twelve (5.88%), a basement floor. The remaining dwellings have only a ground floor, in sixty five cases (31.86%). Multi-storey houses are rare. They are mostly two storeys high, with the second floor generally occupying a small percentage of the ground floor area. The mezzanine is mostly used as an office or library, but in some cases it is used as a natural extension of the receiving rooms. The basement floor is invariably used for service activities, unless in rare cases it is occupied as a playroom (Domingues House).

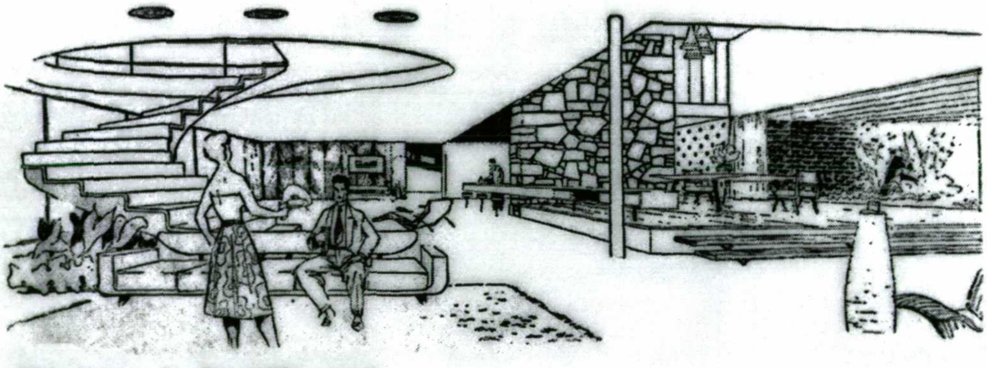
The sample is also diverse in the actual size of the houses. The site area varies from 160.00m^2 to 3900.00m^2, with an average of 666.49m^2. The houses' area ranges from 102.00m^2 to 790.00m^2, with an average of 286.32m^2. Figure 3.3 plots site and houses area, whereas figure 3.4., shows the histograms for the same data. The figures express how concentrated the sample is above and bellow the average values. Indeed, the plots tend to cluster around 500.00m^2, whereas the houses are on average between 200.00 and 300.00 m^2. Small dwellings and large mansions are therefore exceptions.



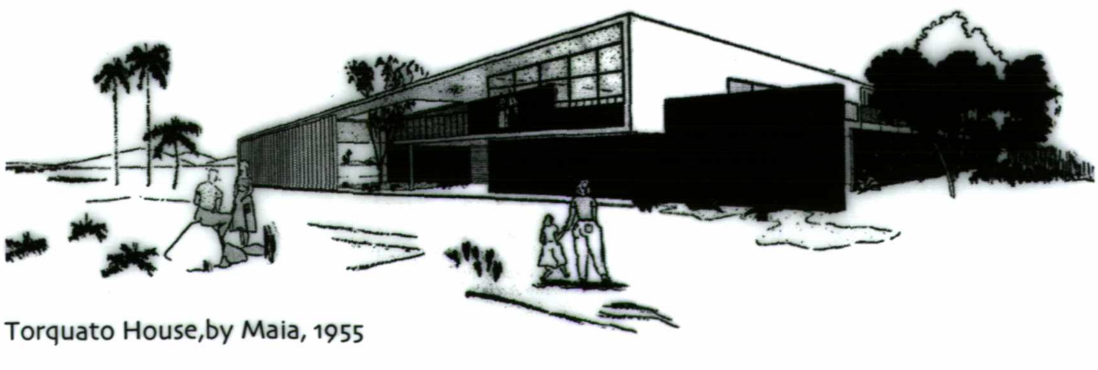
Medeiros House (M4), by Russo, 1949



Tambaú village, by Pinto, 1956



Maia House, by Reynaldo, 1958



Torquato House,by Maia, 1955

Figure 3.2.a. Modern houses of Recife

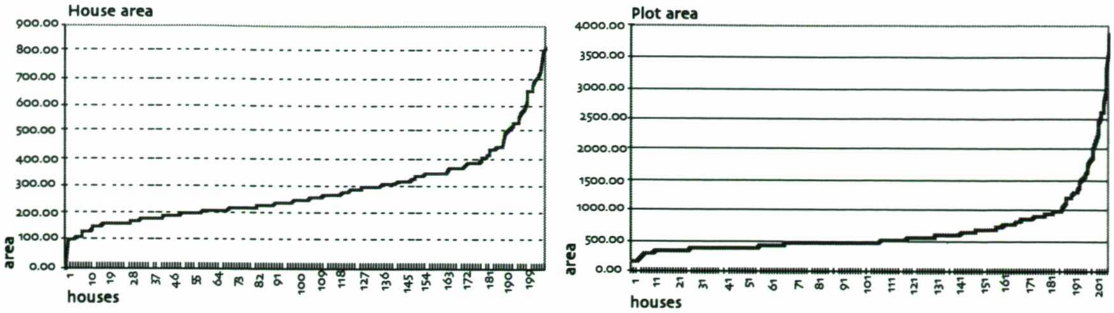


Figure 3.3. Distribution of sites (a) and houses (b) areas

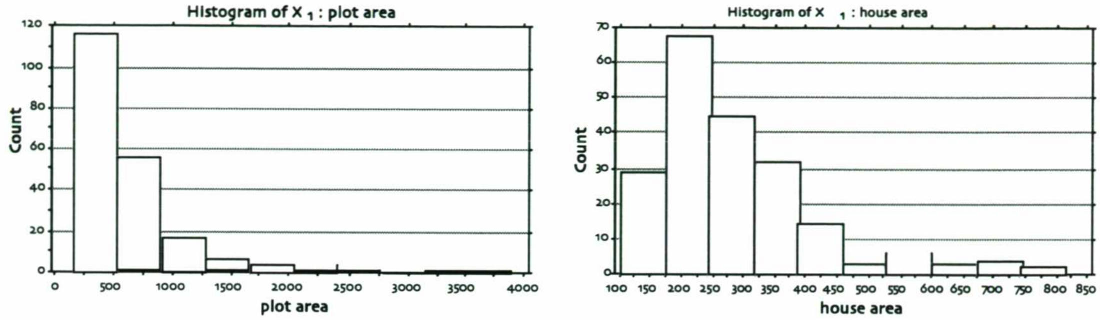


Figure 3.4. Histograms with the distribution of sites' (a) and houses' (b) areas

The dwellings also vary in topological size, i.e., in the number of indoor and outdoor convex spaces. The number of internal convex spaces range from 19 to 60, with an average of 34.63 for the sample. The whole complex, which combines indoor and outdoor spaces, ranges from 35 to 77 convex units, with an average for the sample of 51.52.

Topological and geometrical sizes have a significant correlation (figure 3.5.). Houses' areas and indoor convex spaces have a positive and significant correlation of 0.63r^2 (p=.0001). The correlation is even stronger when house area is compared to the total number of convex spaces (0.708r^2, p=.0001). These results indicate that the bigger the house, the higher the degree to which they are broken up into convex spaces, as already announced by the architects' houses sub-sample. Plot size, however, is not a good indicator of convex articulation (figure 3.6.). The correlation between plot area and indoor convex spaces is 0.193r^2 (p=.0001) and for the whole complex is 0.255 r^2 (p=.0001).

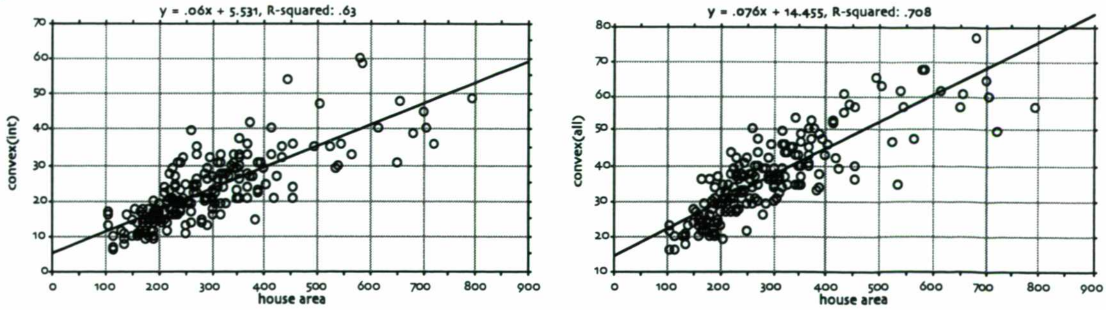


Figure 3.5. Scattergrams of house area and convex spaces: a) indoors b) the whole complex

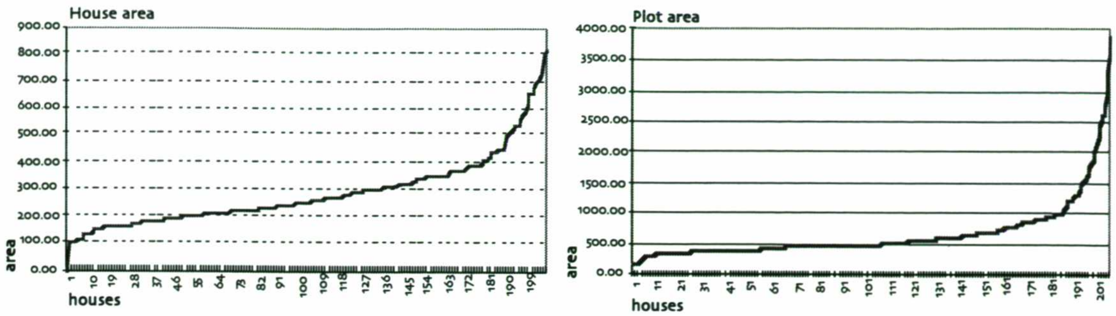


Figure 3.3. Distribution of sites (a) and houses (b) areas

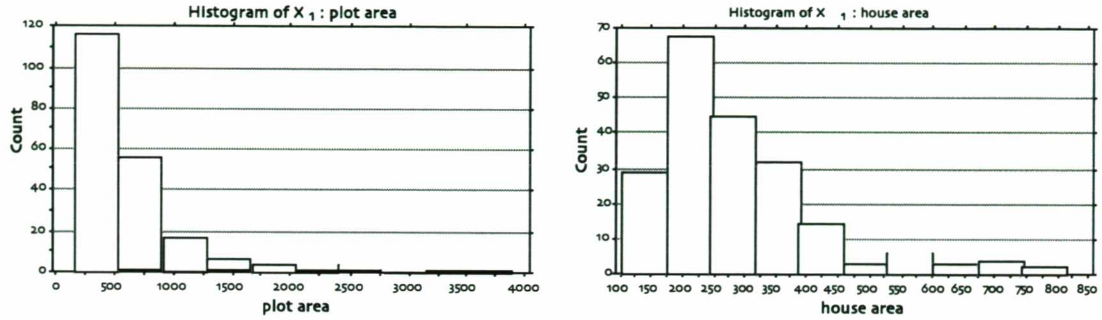


Figure 3.4. Histograms with the distribution of sites' (a) and houses' (b) areas

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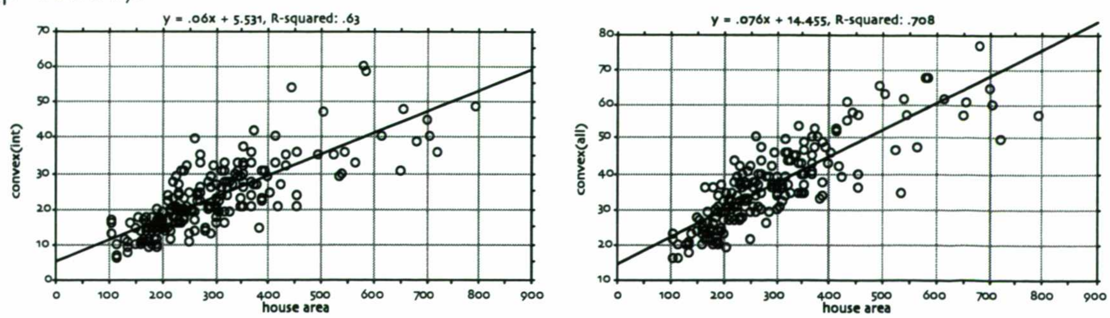
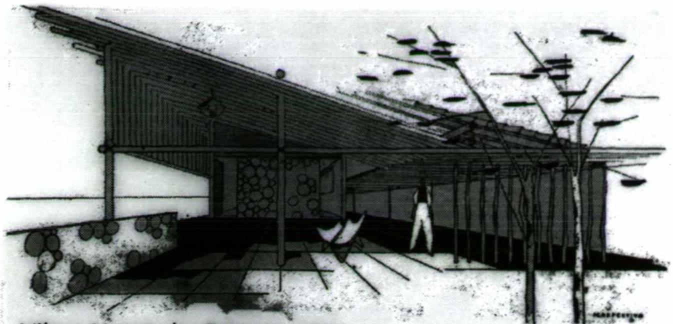
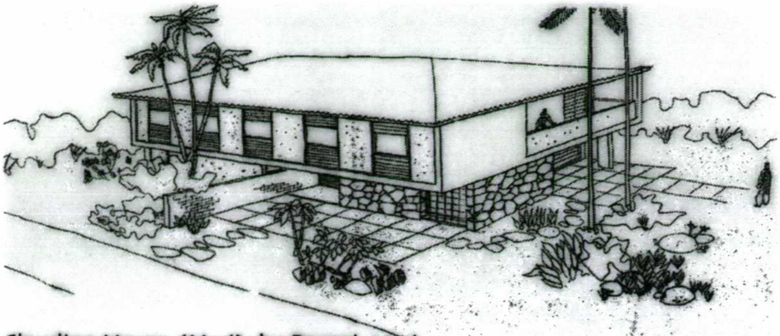


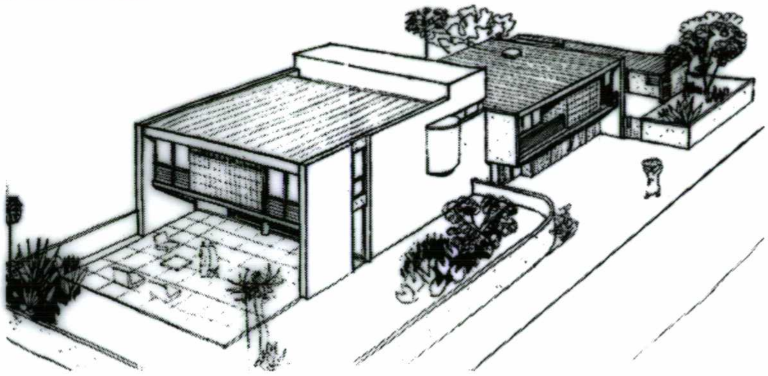
Figure 3.5. Scattergrams of house area and convex spaces: a) indoors b) the whole complex



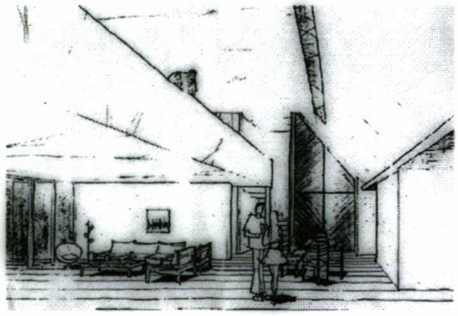
Vilaça House, by Esteves, 1955



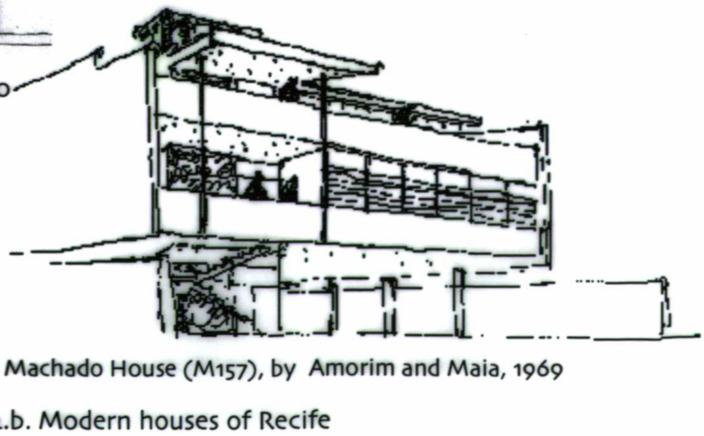
Claudino House (M26), by Borsoi, 1956



Petribú House (M147), by Borsoi, 1968



Cunha House, by Domingues, 1970



Machado House (M157), by Amorim and Maia, 1969

Figure 3.2.b. Modern houses of Recife

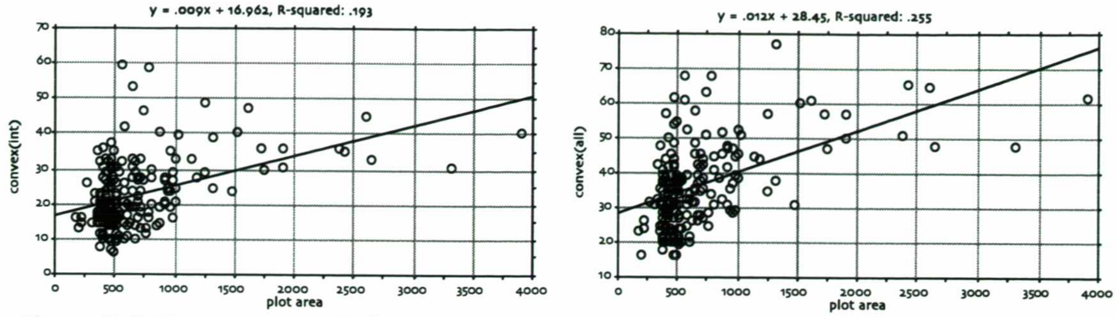


Figure 3.6. Scattergrams of plot area and convex spaces: a) indoors b) the whole complex

The sample is unevenly distributed per decade (figure 3.7.a.). The 1950's and 1960's have a higher concentration percentage, 31.37% and 47.54%, respectively. This results from an objective intent in focusing the research in the period where modernism was intensively developed. Houses designed prior to the 1950's are restricted to five cases (2.45%), and late exemplars from the 1970's correspond to 18.13% of the cases, whereas a single 1980's house (0.49%) is present in the sample.

One preoccupation while gathering exemplars for study was to achieve an even distribution of cases in the city; therefore accounting for different social and urban characteristics, like urban regulations, plot size and orientation, landscape, etc. Figure 3.7.b., shows how the sample is distributed in Recife's districts and neighbour cities. The Sixth District, with 36.27%, the Fourth, with 24.02% and the Third, 21.56%, give the highest concentration of cases. They correspond to expansions of the city fabric occupied by residential areas along the 1950's and 1960's. The reduced number of exemplars located at the Second (3.43%) and Fifth (0.49%) districts are due to archives' losses. This unbalanced distribution does not affect the representativeness of the sample, while the remaining districts are already socially and geographically diverse.

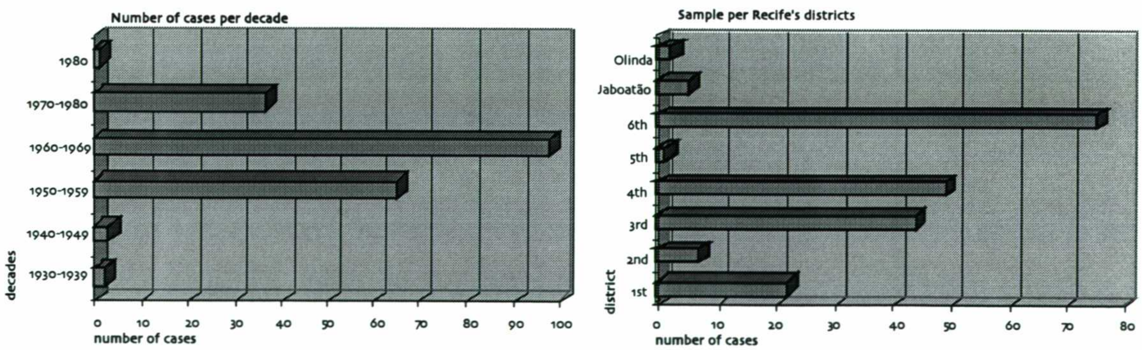
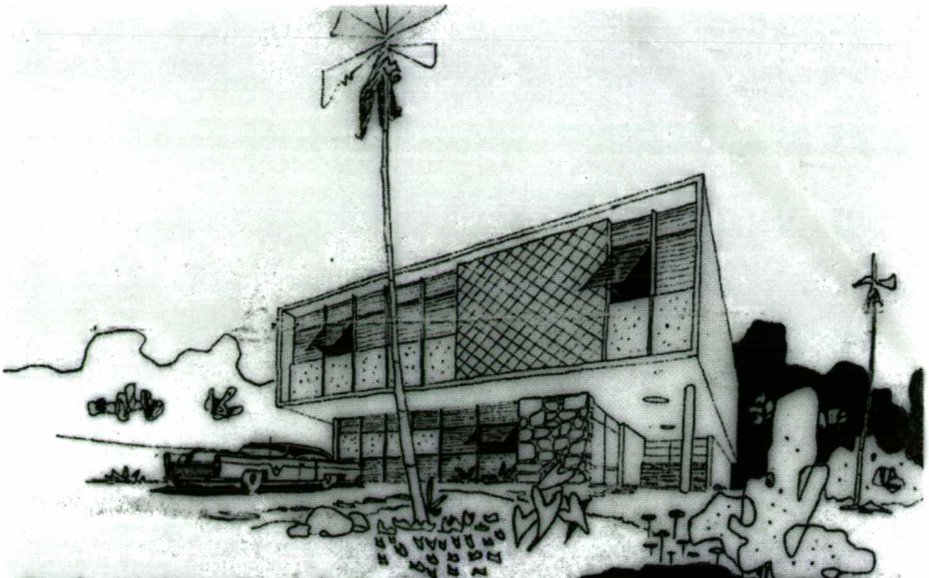
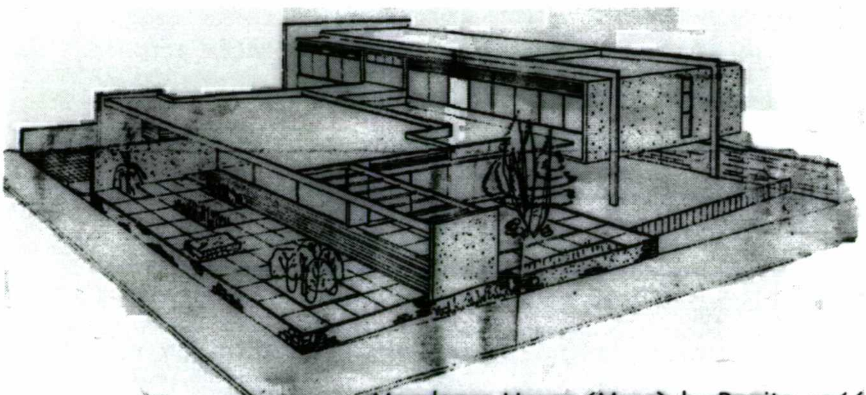


Figure 3.7. The modernist dwelling: a) distribution of cases per decade, b) distribution of cases per district and neighbour cities

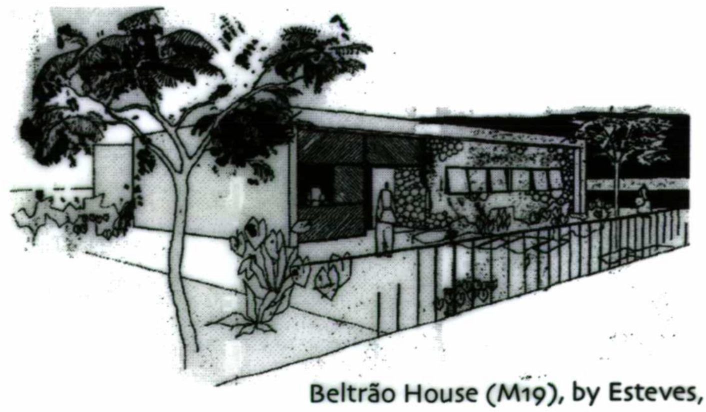
This representativeness is accounted for, for example in its distribution by social classes. The majority of houses are from high-middle-class families, 91 cases (44.60%), followed by middle-class dwellings, 75 cases (36.76%), and upper-class, with 38 occurrences (18.62%).



Cavalcanti House (M23), by Reynaldo, 1955



Mendonça House (M125), by Benito, 1966



Beltrão House (M19), by Esteves, 1955

Alcoforado House (M44), by Domingues, 1957

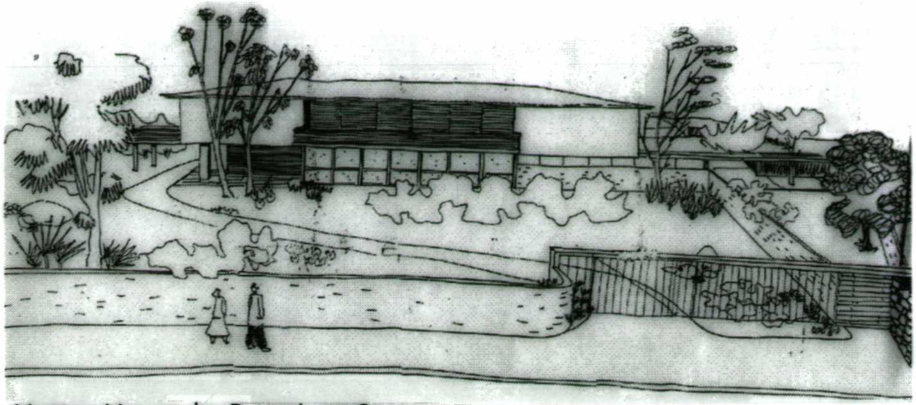
Figure 3.2.c. Modern houses of Recife

Upper-class houses are mostly in storeys (89.47%), but a few are ground floor (10.52%). Their average plot area is 1216.36m^2 and house area is 471.97m^2. The average number of indoor convex spaces is 34.63, and 51.52, for the whole complex. Almost all upper-class houses were designed by architects (92.10%). The only exceptions are the houses designed by the engineers Hugo Marques, José Norberto and Joaquim Rodrigues (figure 3.8.). Upper-class houses are mostly found in Sixth (44.73%) and Third (21.05%) districts, which correspond to the more sophisticated neighbourhoods of Boa Viagem, Casa Forte and Monteiro.

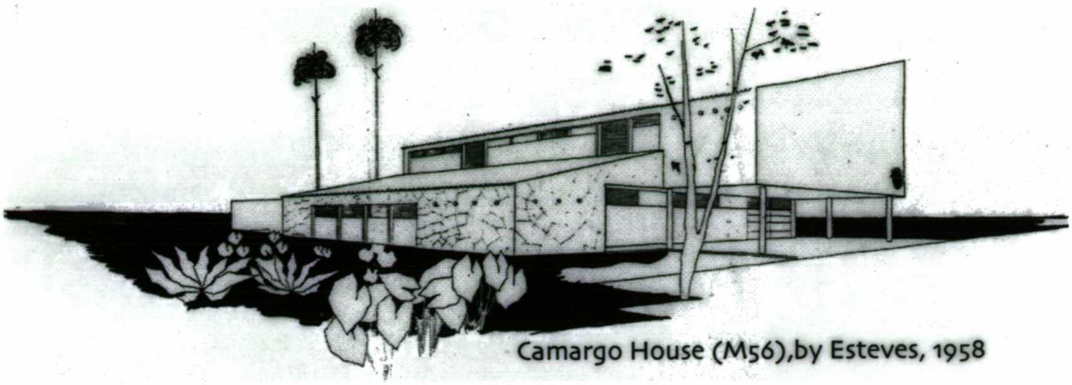
Figure 3.8. Castro e Silva House (M33), by Norberto

High-middle class houses are also mostly in storeys (74,72%), but are also seen with mezzanine (2 cases) and basement (10 occurrences). Plot sizes range from 175.00m^2 to 2,370.00m^2, and house area from 154.00m^2 to 451,00m^2, with an average of 595.95m^2 and 288.47m^2, respectively. The average number of indoor convex spaces is 23.84, ranging from 12 to 38 units. Values for the whole complex range from 16 to 61, with an average of 37.69 convex spaces. Architects are also predominant in the design of high-middle class houses (91.01%), but engineers are relatively fewer than in upper-class houses (6.74%). They are mostly found in Sixth (34.06%) and Third (29.67%) districts, some in the Fourth district (25.27%) as well.

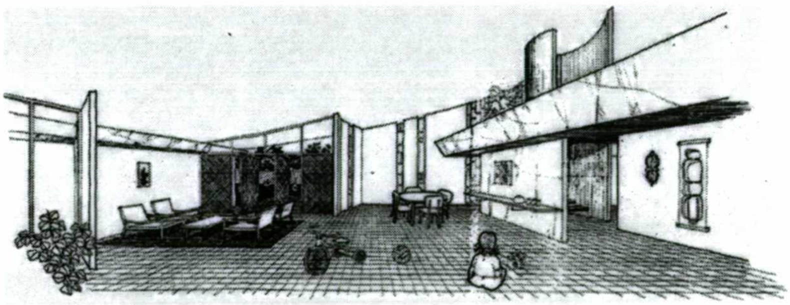
The middle-class group is predominantly ground floor (66.66%), but there are significant number of multi-storey buildings (24.00%). The average plot area is 473.46m^2 and house area is 189.65m^2. The middle-class houses present an average of 27.01 convex spaces, with 15.13 indoor convex spaces on average, establishing an expected correlation between social class and geometrical and topological sizes, as mean values are smaller than the values found in the remaining social classes. Curiously, middle-class houses present the highest percentage of works designed by engineers (17.56%), perhaps because of the feeling that architects tend to be expensive professionals, or tend to increase costs of construction.



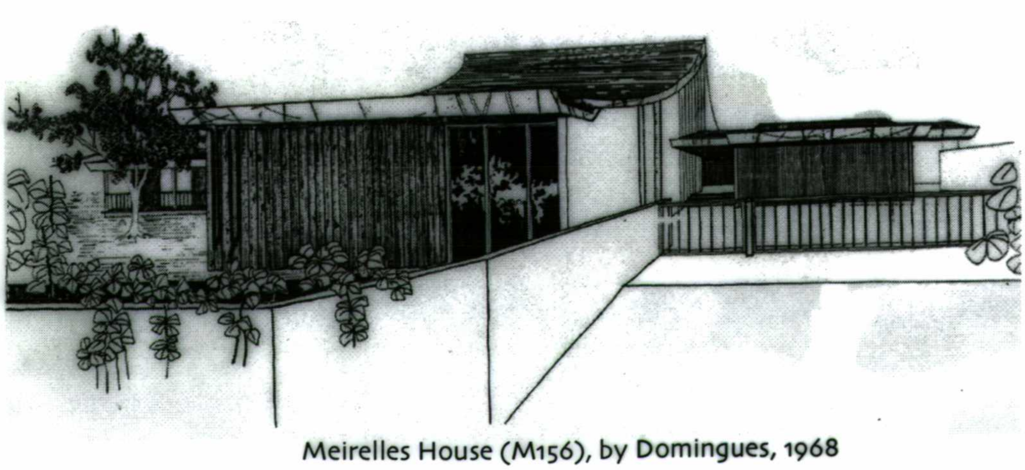
Mattos House, by Borsoi, 1958



Camargo House (M56),by Esteves, 1958



Meirelles House (M156), by Domingues, 1968



Meirelles House (M156), by Domingues, 1968

Figure 3.2.d. Modern houses of Recife

3.2. From diagrams to buildings

The plans of the modern houses which are discussed here are included in a laser disk, attached to the thesis volume, and the syntactic data, expressed house-by-house is shown in table A.3.2., included in Appendix 3. Recife's modern domestic stock, despite its variety of shapes, sizes and character, demonstrates how an architectural idea can be so pervasive as to shape the domestic environment in its entirety. All the modern houses which compose the sample, without any exception, were clearly organised into sectors. This demonstrates that, more than a design strategy exclusively used by architects to conceive their own houses, sectoring was a practice adopted as a design procedure. It also reassures that the rhetoric sectoring idea was clearly manifested in the space-function nature of the dwellings. The types of sectors' arrangements found in the sample and their configurational properties are presented in figure 3.9. and table 3.1., respectively.

However, if the architects' Recife houses studied in the previous chapter were individually sectored, this larger sample presents a certain degree of repetition. Indeed, thirty four different sectors' arrangements were found, with a ratio of one arrangement for each six houses. The variety of sectors' graphs was generated by exploring the potential combination of the basic sectors - social, service, private and mediator, plus the exterior. Notwithstanding the vast field of possible combinations of these elements (four hundred and twenty) secondary sectors were also introduced, multiplying the potential field of combinatorial possibilities. These secondary sectors correspond either to special brief requirements or design strategies. Social areas are to be found separated in a second group of spaces in three conditions. Firstly, they are found as elaborated rooms for formal or ceremonials occasions. Second, they are comprised of guests' accommodations, normally set apart from inhabitants' rooms, but shallow from the living areas. Thirdly, the secondary social sector is composed by social toilets and/or bathrooms, situated slightly apart from the main social areas, but not placed deep amongst inhabitants rooms.

Service spaces are mostly bound together in continuos chain of spaces, but in one exceptional case, the kitchen is isolated from the service quarters, being closer to the dining room (graph T34 in figure 3.9). Even so, the kitchen is reconnected to the service and social areas by means of a mediator sector, thus maintaining its recessed position in relation to the social area.

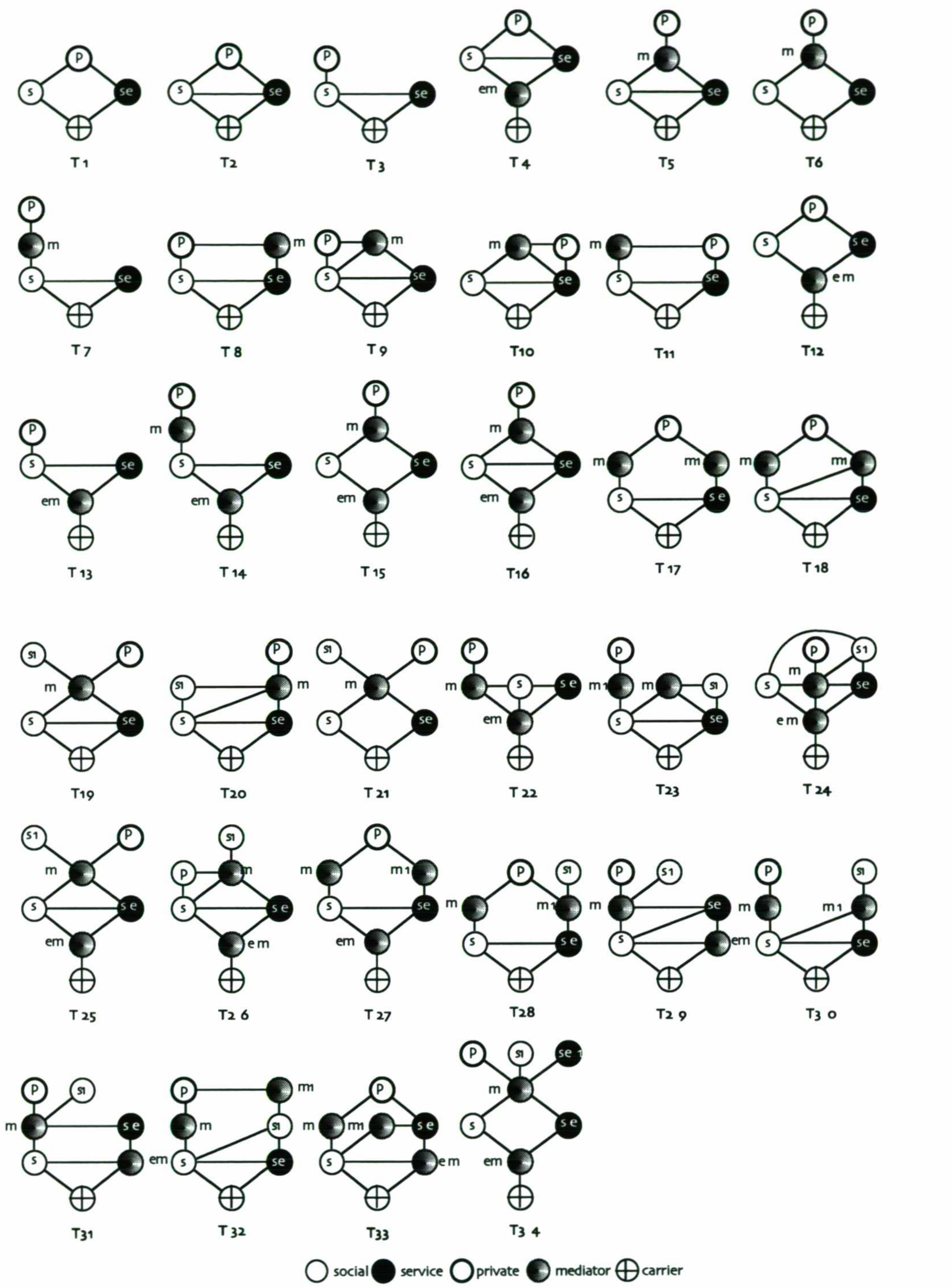


Figure 3.9. The modern sectors' graphs

Finally, mediation is always multiplied to favour the segregation of activities or independent access to/from particular sectors. In most of the cases, they correspond to a secluded access from service to private sectors, but in other circumstances they appear as a buffer zone between the house itself and the pavement. If increasing the number of nodes, and consequently augmenting the potential forms of combining them, establishes grounds for an extensive compositional exercise, it makes the generation of genotypical arrangements even more difficult. Paradoxically, combinatorial freedom reduces the

Table 3.1. The sectors' graphs: syntactic data

Sectors			House						Social			Social 1			Service			Service 1			Private			Mediator			Mediator1			Ext. Mediator			Exterior		
types	size	cases	MRRA	a-ness	b-ness	c-ness	d-ness	DV	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA
T1	4	3	0.999	0.00	0.00	1.00	0.00	4.00	c	1	0.999				c	1	0.999				c	2	0.999										c	0	0.999
T2	4	22	0.499	0.00	0.00	0.50	0.50	2.00	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
T3	4	8	0.999	0.33	0.00	0.75	0.00	2.77	c	1	0.000				c	1	0.999				a	2	1.999										c	0	0.999
T4	5	3	0.946	0.25	0.00	0.40	0.40	1.52	d	2	0.473				d	2	0.473				c	3	1.420							c	1	0.473	a	0	1.893
T5	5	40	0.946	0.25	0.00	0.40	0.40	1.52	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
T6	5	4	1.136	0.25	0.00	0.80	0.00	3.05	c	1	0.946				c	1	0.946				a	3	1.893	c	2	0.473							c	0	1.420
T7	5	44	1.325	0.25	0.33	0.60	0.00	2.03	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
T8	5	1	0.757	0.00	0.00	0.60	0.40	2.40	d	1	0.473				d	1	0.473				c	2	0.946	c	2	0.946							c	0	0.946
T9	5	7	0.568	0.00	0.00	0.40	0.60	2.40	d	1	0.000				d	1	0.473				c	2	0.946	d	2	0.473							c	0	0.946
T10	5	3	0.568	0.00	0.00	0.40	0.60	2.40	d	1	0.473				d	1	0.000				c	2	0.946	d	2	0.473							c	0	0.946
T11	5	2	0.757	0.00	0.00	0.60	0.40	2.40	d	1	0.473				d	1	0.473				c	2	0.946	c	2	0.946							c	0	0.946
T12	5	1	1.136	0.25	0.00	0.80	0.00	3.05	c	2	0.946				c	2	0.946				c	3	1.420							c	1	0.473	a	0	1.893
T13	5	4	1.136	0.50	0.00	0.60	0.00	2.18	c	2	0.473				c	2	0.946				a	3	1.893							c	1	0.473	a	0	1.893
T14	6	13	1.337	0.20	0.25	0.67	0.00	2.39	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
T15	6	2	1.241	0.40	0.00	0.67	0.00	2.50	c	2	0.859				c	2	0.859				a	4	2.005	c	3	0.859				c	1	0.859	a	0	2.005
T16	6	8	1.146	0.40	0.00	0.33	0.33	1.50	d	2	0.573				d	2	0.573				a	4	2.005	c	3	0.859				c	1	0.859	a	0	2.005
T17	6	10	0.859	0.00	0.00	0.67	0.33	2.67	d	1	0.573				d	1	0.573				c	3	1.146	c	2	0.859	c	2	0.859				c	0	1.146
T18	6	2	0.764	0.00	0.00	0.50	0.50	2.00	d	1	0.286				d	1	0.573				c	3	1.146	c	2	0.859	d	2	0.573				c	0	1.146
T19	6	8	0.955	0.40	0.00	0.33	0.33	1.50	d	1	0.573	a	3	1.432	d	1	0.573				a	3	1.432	c	2	0.286							c	0	1.432
T20	6	1	0.764	0.20	0.00	0.33	0.50	1.94	d	1	0.286	c	2	0.859	d	1	0.573				a	3	1.432	d	2	0.286							c	0	1.146
T21	6	1	1.050	0.40	0.00	0.67	0.00	2.50	c	1	0.859	a	3	1.432	c	1	0.859				a	3	1.432	c	2	0.286							c	0	1.432
T22	6	1	0.955	0.40	0.00	0.33	0.33	1.50	d	2	0.573				c	2	1.146				a	3	1.719	c	2	0.573				d	1	0.286	a	0	1.432
T23	7	1	1.009	0.17	0.20	0.29	0.43	0.97	d	1	0.392	c	2	1.373	d	1	0.588				a	3	1.962	d	2	0.785	b	2	0.981				c	0	0.981
T24	7	1	0.729	0.33	0.00	0.00	0.71	2.73	d	2	0.588	d	3	0.785	d	2	0.588				a	3	1.177	d	2	0.196				d	1	0.392	a	0	1.373
T25	7	4	1.121	0.50	0.00	0.40	0.40	1.54	d	2	0.588	a	4	1.570	d	2	0.588				a	4	1.570	c	3	0.588				c	1	0.981	a	0	1 962
T26	7	1	0.953	0.33	0.00	0.29	0 43	1.64	d	2	0.392	a	4	1.570	d	2	0.588				c	3	0.981	d	3	0.588				c	1	0.785	a	0	1 766
T27	7	1	1.009	0.17	0.00	0.57	0.29	2.24	d	2	0.588				d	2	0.588				c	4	1.373	c	3	0.981	c	3	0.981	c	1	0.785	a	0	1.766
T28	7	1	0.953	0.17	0.00	0.57	0.29	2.24	d	1	0.785	a	3	1.570	d	1	0.588				c	3	0.981	c	2	0.981	c	2	0.588				c	0	1.177
T29	7	1	0.897	0.33	0.00	0.29	0 43	1.64	d	1	0.392	a	3	1.373	d	2	0.588				a	3	1.373	c	2	0.392				d	1	0.981	c	0	1.177
T30	7	2	1.121	0.33	0.20	0.29	0.29	0 48	d	1	0.392	a	3	1.766	d	1	0.785				a	3	1.962	b	2	0.981	c	2	0.785				c	0	1.177
T31	7	1	0.953	0.33	0.00	0.43	0.29	1.64	d	1	0.588	a	3	1.373	c	2	0.785				a	3	1.373	c	2	0.392				d	1	0.981	c	0	1.177
T32	7	1	0.841	0.00	0.00	0.57	0.43	2.29	d	1	0.392	d	2	0.588	d	1	0.785				c	3	1.177	c	2	0.785	c	3	0.981				c	0	1.177
T33	7	1	0.729	0.00	0.00	0.57	0.43	2.29	d	1	0.392				d	2	0.588				c	3	0.981	c	2	0.785	c	2	0.785	d	1	0.588	c	0	0.981
T34	8	1	1.087	0.57	0.00	0.50	0.00	2.13	c	2	0.725	a	4	1.305	c	2	0.725	a	4	1.305	a	4	1.305	c	3	0.435				c	1	1.015	a	0	1.885
Mean	5.91	6	0.948	0.227	0.029	0.503	0.295	2.12		1.35	0.517		3	1.307		1.44	0.685		4	1.305		2.97	1.456		2.25	0 665		2.25	0.817		1	0.719		0	1.384

possibility of generating genotypical arrangements. The following analysis reveals how designers overcame this combinatorial paradox by imprinting consistent configurational properties in the sectors' arrangements.

3.2.1. Topological size

The identified sectors' graphs (figure 3.9.) range from four to eight nodes according to the introduction of secondary sectors to the basic social-service-private-mediator sectors model. The first group of four element graphs is found in three different arrangements (T1 to T3), in 33 dwellings, or in 16.18% of the sample. These graphs, the simplest of the sample, represent the houses which do not use a mediator sector, thus indicating more integration between the sectors. These simple graphs are mostly found amongst ground floor (21 cases - 63.64%) and middle-class (22 occurrences - 53.33%) houses. The average plot and house area are the smallest of the sample (603.78m^2 and 240.40m^2, respectively), as well as the average number of convex spaces (17.90 indoors and 30.87 for the whole complex).

Table 3.2. General data by topological size

Size	Cases		Social class *						Levels								Area (m2)		Convex	
	total	%	mc	%	hmc	%	uc	%	grd	%	mez	%	bas	%	str	%	Plot	House	All	Interior
4	33	16.18	22	53.33	7	21.21	4	12.12	21	63.64	4	12.12	2	6.06	6	18.18	603.78	240.4	30.9	17.90
5	109	53.43	40	36.70	56	51.38	13	11.9	34	31.19	3	2.75	8	7.34	64	58.72	668.77	276.00	35.4	21.9
6	46	22.55	12	26.09	18	39.1	16	34.8	8	17.39	0	0.00	2	4.35	36	78.3	699.34	327.10	39.2	25.2
7	15	7.35	1	6.67	9	60.00	5	33.3	2	13.33	0	0.00	0	0.00	13	86.7	709.34	338.40	45.60	30.1
8	1	0.49	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00	332.00	270.00	48.00	35.00

* The percentage values are calculated on the basis of the number of occurrences by graphs' size

The more informal disposition of the sectors proposed by these non-mediated houses may reflect the interest of both architects and inhabitants in building up a domestic structure which has less restricted or regulated boundaries, even though perfectly arranged into zones. This intent may be related to simple lifestyles, freed from strict social conventions, or to architectural experimentalism. For example, Marinho house (M188), studied in depth in chapter six (see figure 6.8.) is a clear example of architectural experimentalism, in which flow of space is extensively explored to dematerialise the boundaries between sectors, therefore expressing a less conventional lifestyle. On the other hand, Alcoforado House (M44) (figure 6.8.) expresses a more conventional lifestyle through its compartmentalised plan, despite being less affected by isolated domestic realms.

The second group of graphs (T4 to T13), introduces a mediator sector, either an internal or an external one. The five element graphs are the most popular set in the sample, grouping 109 cases (53.43%). This group is significantly present amongst middle-class (40 cases, 36.70%) and high-middle-class (56 houses, 51.37%) houses, as well as in multi-storey buildings (64 cases - 58.72%). The sheer predominance of multi-storey houses is an indicative of the use of stairways, staircases and ramps as means of isolating sectors. In fact, organising sectors in different floors and using the staircase as a buffer zone is one of the commonest schemes identified in the sample. Medeiros House (M4) is a typical example of this solution (figure 6.8., in chapter 6).

Graphs T5, T6, T9 and T10 accurately follow with the optimal sectors' arrangement, by mediating the relationship between the main functional sectors, even if direct connections are needed between them. They are found in fifty four cases (26.47%), demonstrating designers' and clients' subordination to an ideal configuration of dwellings. Domingues House (M102), detailed in the previous chapter is an example of this model (figure 2.24.).

House and site areas, and indoors and outdoors convex units are found in higher figures than amongst the four element graphs. This indicates that the more complex the sectors' graphs, the more complex and sophisticated the houses are.

The six element graphs, T14 to T22, are the second in terms of occurrence, 46 cases, corresponding to 22.55% of the dwellings. These graphs are absolutely predominant amongst high social classes and multi-storey houses. Their geometrical and topological sizes are again higher than the previous graphs, confirming the positive correlation between sectors' and houses size. The complexity of houses' programs is also apparent by the introduction of secondary sectors. A second mediation sector is used in graphs T17 and T18 to allow independent movement from the service sector to the private one and higher choice of movement. These schemes are applied in 12 dwellings, mostly upper-class (9 cases - 60.00%%) and in levels (11 cases - 86.67%), as for example Lages House (see figure 6.8.).

The sub-division of the social sector (graphs T19 to T21) corresponds either to guests premises or to social toilets and/or bathrooms. The former comprises bedroom(s), bathroom(s) and ancillary rooms, grouped and arranged in a separate part of the complex, stating the isolation of the actual members of the family from occasional guests. The latter consists of a typical solution of recessing the social toilet from the main social areas, by connecting the toilet to the mediator zone (see Esteves House, figure 2.21.)

The last two groups comprise the most complex graphs, composed of seven (T23 to T33) and eight nodes (T34). They are the least popular graphs, suggesting either experimentalism or attendance to particular requirements of the brief. The arrangements are in most of the cases unique, proving that their individuation is a question of programmed requirement or architectural experimentation. This is observed, for example, in Borsoi (M22) and Svenson (M154) houses (figures 2.18. and 2.20.), in which the spatial composition of the dwellings is very much a response to the architects' speculative thinking. Secondary sectors and mediators are extensively applied in these seven and eight element graphs, which are mostly found in high-middle-class and two storey houses.

The relationship between the type of sectors' graphs and social background is also observed in table 3.3. and figure 3.10. Table 3.3. identify the types of graphs according to social class and figure 3.10. shows the percentage of occurrence of social class by sectors' graph. The results show clearly that middle class houses tend to be organised in a less number of sectors, whereas high-middle and upper classes are organised in more complex forms. Middle class dwellings correspond to 67.00% of the four element graph, but this number drops significantly to 37.00%, 27.00% and 7.00% amongst the five, six and seven element graphs, respectively. Upper class houses present the opposite pattern. Its occurrence increases from 12.00%, within the four element graph's houses to 40.00% for the seven element graphs. High-middle class houses follow a similar pattern, increasing its perceptual value with the size of the graphs. It is the second in occurrence amongst the four element graphs (21.00%) and forms the majority of the five (51.00%), six (37.00%), seven (53.00%) and eight (100.00%) element graphs.

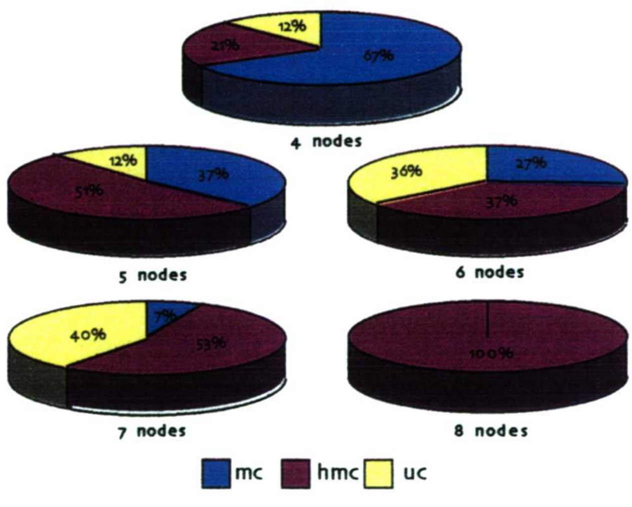


Figure 3.10. Topological size by social class

Table 3.3. Types of graphs by social class

Size	type	mc cases	%	hmc cases	%	uc cases	%
4 nodes	T1	3	100.00	0	0.00	0	0.00
	T2	16	72.73	4	18.18	2	9.09
	T3	3	37.50	3	37.50	2	25.00
	total	22	66.67	7	21.21	4	12.12
5 nodes	T4	1	33.33	2	66.67	0	0.00
	T5	17	42.50	17	42.50	6	15.00
	T6	0	0.00	4	100.00	0	0.00
	T7	15	34.09	25	56.82	4	9.09
	T8	0	0.00	1	100.00	0	0.00
	T9	2	28.57	4	57.14	1	14.29
	T10	3	100.00	0	0.00	0	0.00
	T11	2	100.00	0	0.00	0	0.00
	T12	0	0.00	1	100.00	0	0.00
	T13	0	0.00	2	50.00	2	50.00
	total	40	36.70	56	51.38	13	11.93
6 nodes	T14	4	30.77	4	30.77	5	38.46
	T15	1	50.00	1	50.00	0	0.00
	T16	3	37.50	4	50.00	1	12.50
	T17	1	10.00	1	10.00	8	80.00
	T18	0	0.00	0	0.00	1	100.00
	T19	2	25.00	5	62.50	1	12.50
	T20	0	0.00	1	100.00	0	0.00
	T21	0	0.00	1	100.00	0	0.00
	T22	1	100.00	0	0.00	0	0.00
	total	12	26.67	17	37.78	16	35.56
7 nodes	T23	0	0.00	0	0.00	1	100.00
	T24	0	0.00	0	0.00	1	100.00
	T25	0	0.00	3	75.00	1	25.00
	T26	1	100.00	0	0.00	0	0.00
	T27	0	0.00	0	0.00	1	100.00
	T28	0	0.00	1	100.00	0	0.00
	T29	0	0.00	1	100.00	0	0.00
	T30	0	0.00	2	100.00	0	0.00
	T31	0	0.00	1	100.00	0	0.00
	T32	0	0.00	0	0.00	1	100.00
	T33	0	0.00	0	0.00	1	100.00
	total	1	6.67	8	53.33	6	40.00
8 nodes	T34	0	0.00	1	100.00	0	0.00
	total	0	0.00	1	100.00	0	0.00

In summary, the size of the sectors' graphs seems to be a function of houses' program. The more complex the program, the more elaborated the functional organisation of the house. This is evident in the generation of secondary functional and mediator sectors, formulated to attend specific requirements of the brief, either functional or social. Furthermore, the complexity of the graph is also a good indicative of the area and the number of convex spaces of the houses, suggesting that the more complex the graphs are, the larger and more convexialy articulated the houses themselves. Finally, the graphs' complexity is also a sign of individuation, because the more complex the graphs are, less chance there is to find them in more than one case.

3.2.2. Space-type analysis

After having observed the graphs according to their topological size, this section observes the sectors' nodes according to the position they assume in the systems. Figure 3.11. shows the sectors' graphs labelled according to Hillier's space-types, and table 3.4, describes their occurrences per sector.

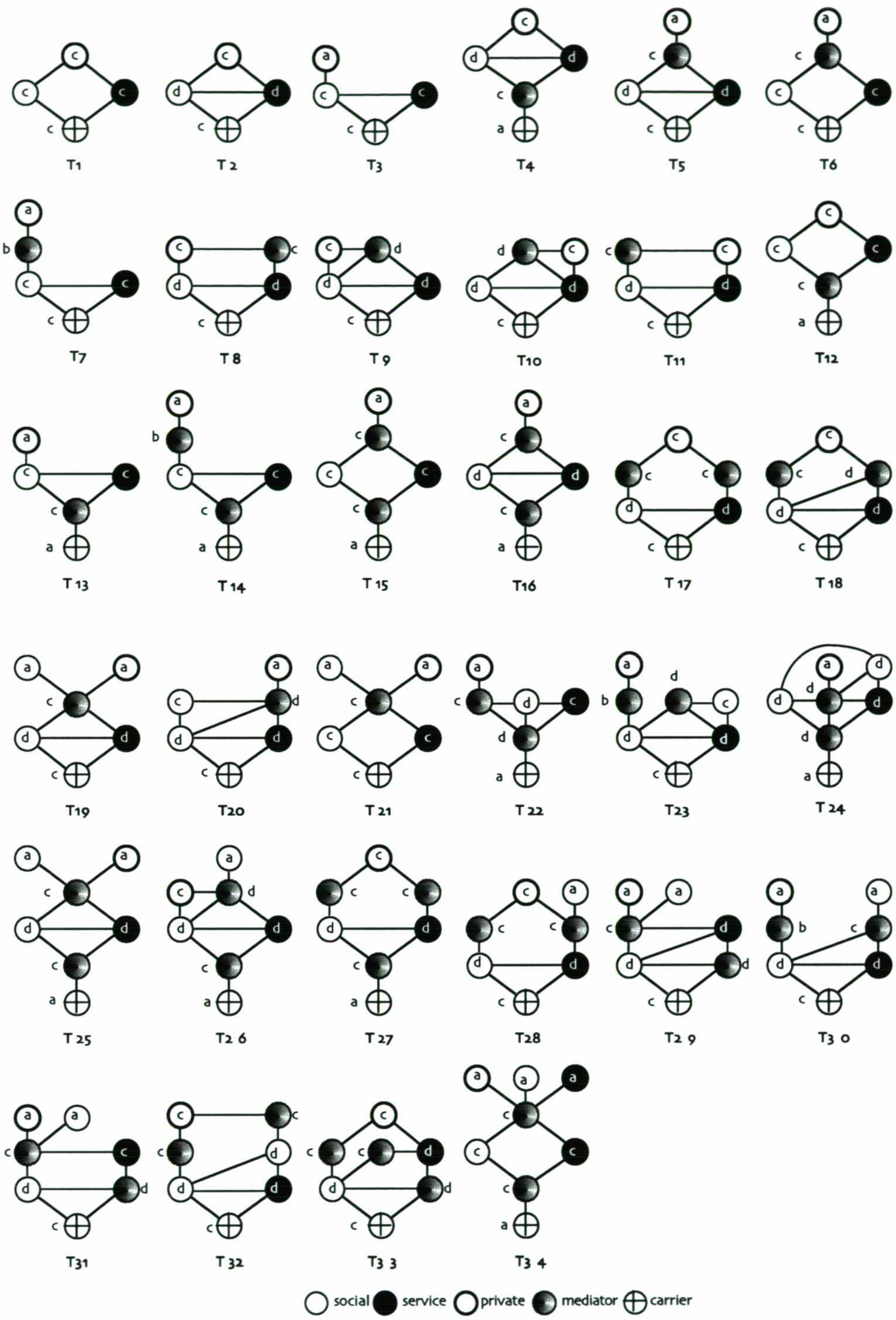


Figure 3.11. Sectors' graphs by space-type

Table 3.4. Space-type: occurrence in the sample

Cases per graphs																		
type	s	%	s1	%	se	%	se1	%	p	%	m	%	m1	%	em	%	e	%
a	0	0.00	9	69.23	0	0.00	1	100.00	19	55.88	0	0.00	0	0.00	0	0.00	11	32.35
b	0	0.00	0		0	0.00	0	0.00	0	0.00	3	10.71	1	12.50	0	0.00	0	0.00
c	10	29.41	2	15.38	12	35.29	0	0.00	15	44.12	19	67.86	6	75.00	10	66.67	23	67.65
d	24	70.59	2	15.38	22	64.71	0	0.00	0	0.00	6	21.43	1	12.50	5	33.33	0	0.00
Cases in the sample																		
type	s	%	s1	%	se	%	se1	%	p	%	m	%	m1	%	em	%	e	%
a	0	0.00	20	83.33	0	0.00	1	100.00	145	71.08	0	0.00	0	0.00	0	0.00	27	13.24
b	0	0.00	0	0	0	0.00	0	0.00	0	0.00	59	36.20	1	5.26	0	0.00	0	0.00
c	81	39.71	2	8.33	83	40.68	0	0.00	59	28.92	90	55.21	16	84.21	38	88.37	177	86.76
d	123	60.29	2	8.33	121	59.31	0	0.00	0	0.00	14	8.59	2	10.53	5	11.63	0	0.00

s=social, se=service, p=private, m=mediator, em=external mediator, e=exterior

The space type analysis for the modernist sample reproduces some of the architects' houses pattern seen in chapter two. For example, social and service sectors are always included, at least, in one ring, being c- or d-type spaces. The social sector appears as a c-type space in 10 graphs, corresponding to 81 cases (39.71%) and as d-type in 24 graphs and in 123 dwellings (60.29%). Similar values are found for the service node, which is found as a c-type space in 12 graphs, corresponding to 40.68% of the dwellings, and as a d-type space in 22 graphs (59.31%).

It seems that there is a general trend in the graphs. Even though being phenotypically composed, the graphs are configured in order to guarantee the same topological position for these functional sectors. If the social sector is included in a c-type complex, so will the service sector. If it is included in a d-type complex, the same will occur. Two exceptions are found. Graphs T22 and T31 have d-social and c-service, corresponding to two isolated cases, Chamixaes House (M48) (figure 6.8.) and Pires House (M160). In both cases, the introduction of an external mediator isolates the service node, and consequently dislocates it from the connectivity hub formed by the social sector and the exterior. Notwithstanding these exceptional cases, social and service sectors seem to have exactly the same topological position. Knowing that d-type complexes are depth minimisers, service and social sectors have the role of globally integrating the system.

The private sector is found as an a-type space in 55.88% of graphs' arrangements and as c-type in 44.12%. However, these values are more expressive when the number of occurrences amongst the dwellings is counted. In fact, the private sector is found as an a-type space in 71.08% of the sample (145 houses), confirming its desirable seclusion. The private sector is located in a ring in very specific conditions. Firstly, when bedrooms are connected to the outside, thus allowing movement to the social areas. These cases appear in graphs T8, T12 and T26. Rocha (M163) Domingues (figure 2.24.) and Svenson (figure 2.30.) houses, are respective examples, but also there are some exemplars of arrangements T1 and T2, as Marinho House (M188) (figure 6.9). Secondly, they occur when access to/from service and social zones is necessary. In these circumstances, the private sector is either directly connected to those sectors or to mediation nodes. In these situations, the servants' connection tend to be lockable. Thus, the private rooms remain as potentially dead-end spaces. Lages house (M16) is a good example of double mediation, allowing social and service access to the bedrooms (figure 6.8.).

The public domain is dominantly a c-type space (67.65% of the graphs - 86.76% of the cases), sharing a shallow ring with the service and social zones. It becomes an a-type space when an external mediator is created. This occurs in two circumstances. Firstly, when a semi-public area recessed from the pavement line is created; as a buffer zone, it isolates public movement from the main entrance of the house, and generates a kind of privacy gradient. They may be seen as ambiguous areas, neither private nor public, 'but transition spaces that can be attributed a built form and contain activity patterns that regulate interpersonal contact according to the aspirations and goals of the residents' (Lawrence, 1987: 172). In the modern dwellings, the concentration of both social and service entrances, allows a higher control of access and surveillance of movement. Petribu House (M149) is a typical example (figure 3.12.). The second circumstance occurs when social and service entrances are drawn one step deeper in the plot, as in Svenson House. Its role is similar to the previous situation; however, the separation of categories is done on the plot of the house. This may suggest either a higher preoccupation in controlling servants' access to the house, or weaker categorisation of spaces.

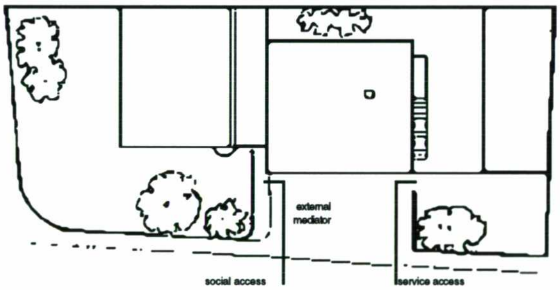


Figure 3.12. Petribu House (M147), by Borsoi, 1968: location plan

The indoor mediator space is the only main sector to appear in three different topological situations. It predominantly appears as a c-type space (67.86% of the graphs and 55.21% of the cases), defining rings, but maximising depth. It also appears as a d-type space, and is always included in the same d-type complex as the social and/or service sectors. Although these cases comprise 21.43% of the graphs, they are only found in 8.56% of the dwellings, in which mediation is used. Finally, the mediator sector is found as a b-type space (graphs T7, T14 and T30), connecting social and private sectors. These cases correspond to a significant 36.20% of the mediated houses.

Secondary sectors have odd occurrences, when compared with the main ones. Secondary social sectors appear in three different situations. As an a-type space, it represents social bathrooms, as found in Esteves, Borsoi and Svenson houses. It is found in nine graphs, corresponding to twenty dwellings. It also appears as c- and d-type spaces, when representing guests' premises or informal receiving areas. These cases correspond to two graphs and two dwellings, each. Secondary service sector appears as an a-type space, in a single case, T34, corresponding to a particular arrangement where the kitchen is isolated from the service sector by means of an internal mediator.

The external mediator is found either as a c- or d-type space, but predominantly as a c-type (66.67% of its occurrences in the graphs and 88.37% of the external mediated houses). The secondary mediation unit is the only one to follow the same pattern of the mediator sector. It is found as c-type (12.50% of its occurrences) and d-type (12.50%), but predominantly as a c-type space (75.00% of its occurrences).

3.2.2.1. Space-type profiles

The degree of space-ness, described and applied in chapter 2, in section 2.2 and sub-sections 2.5.1 and 2.5.3.2., has proved to be valuable to evaluate how the graphs are topologically composed. Moreover, plotting space-ness values in a graph has revealed in their profiles similarities between graphs, otherwise unseen. The space-ness values for the sample are presented in table 3.1., and the space-ness profiles are presented in figures 3.13. to 3.18. Table 3.5. sums up the space-type profiles data.

Table 3.5. The space-type profiles

Space-type profiles profile	inequality	graphs	houses	% sample	ratio h:g	MDV
inverted-v	a<b<c>d	2	57	27.94	0.04	2.21
v-shape	a>b<c≤d	10	69	33.82	0.14	1.48
s-shape	a=b<c≥d	8	42	20.59	0.19	2.50
j-shape	a=b<c<d	2	10	4.90	0.20	2.40
sinusoid	a>b<c>d	10	24	11.76	0.42	2.43
linear	a<b<c<d	1	1	0.49	1.00	0.97
u-shape	a>b=c<d	1	1	0.49	1.00	2.73

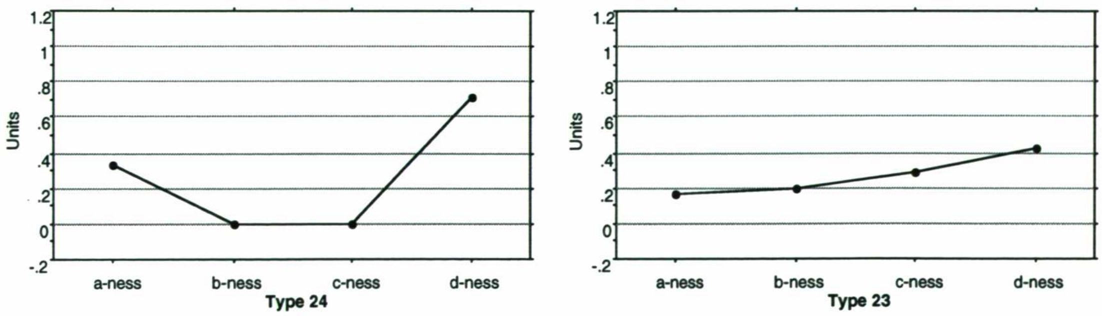


Figure 3.13. Space-type profiles: 'u-shape' and 'linear' profiles

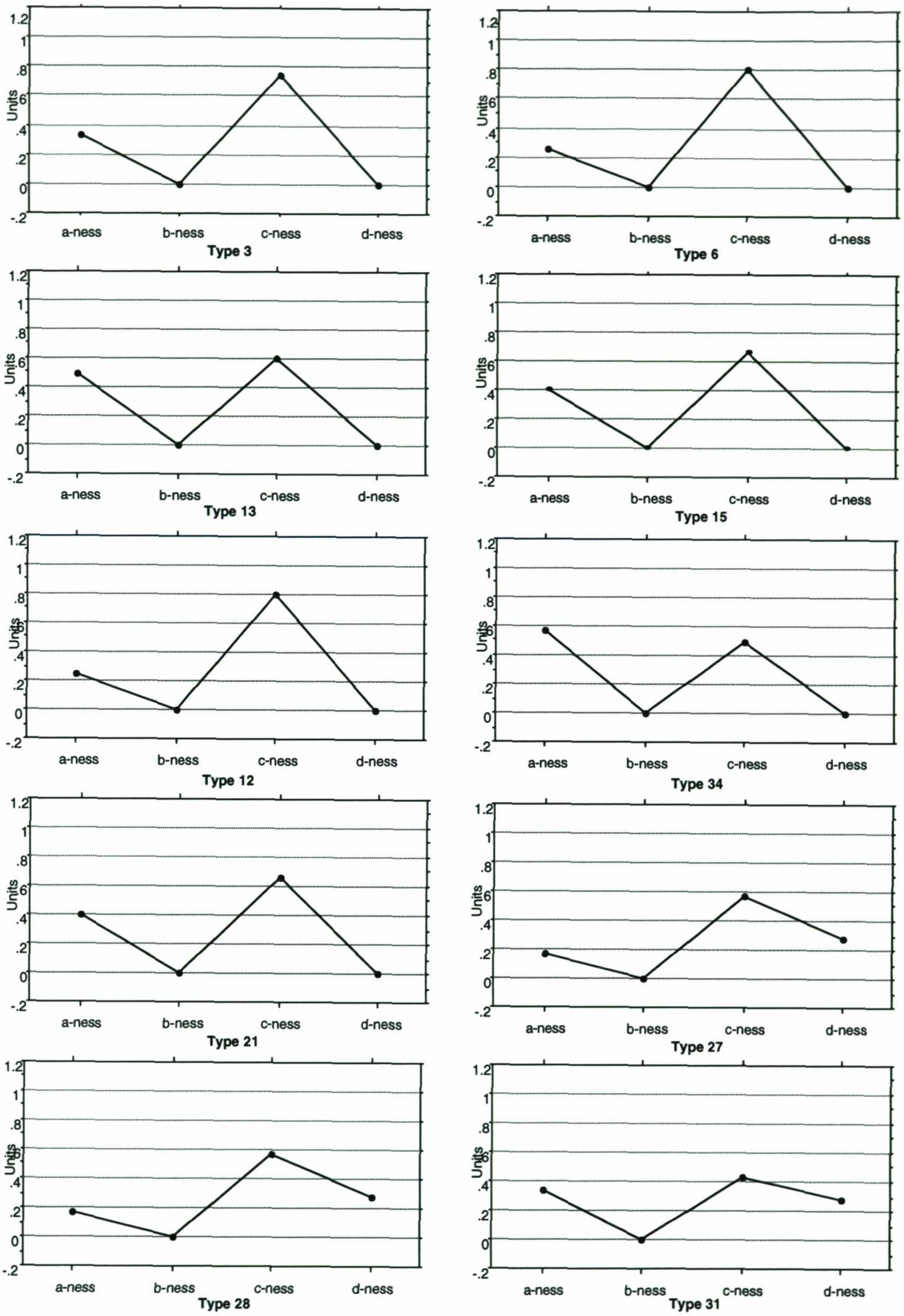


Figure 3.14. Space-type profiles: 'sinusoid' profile

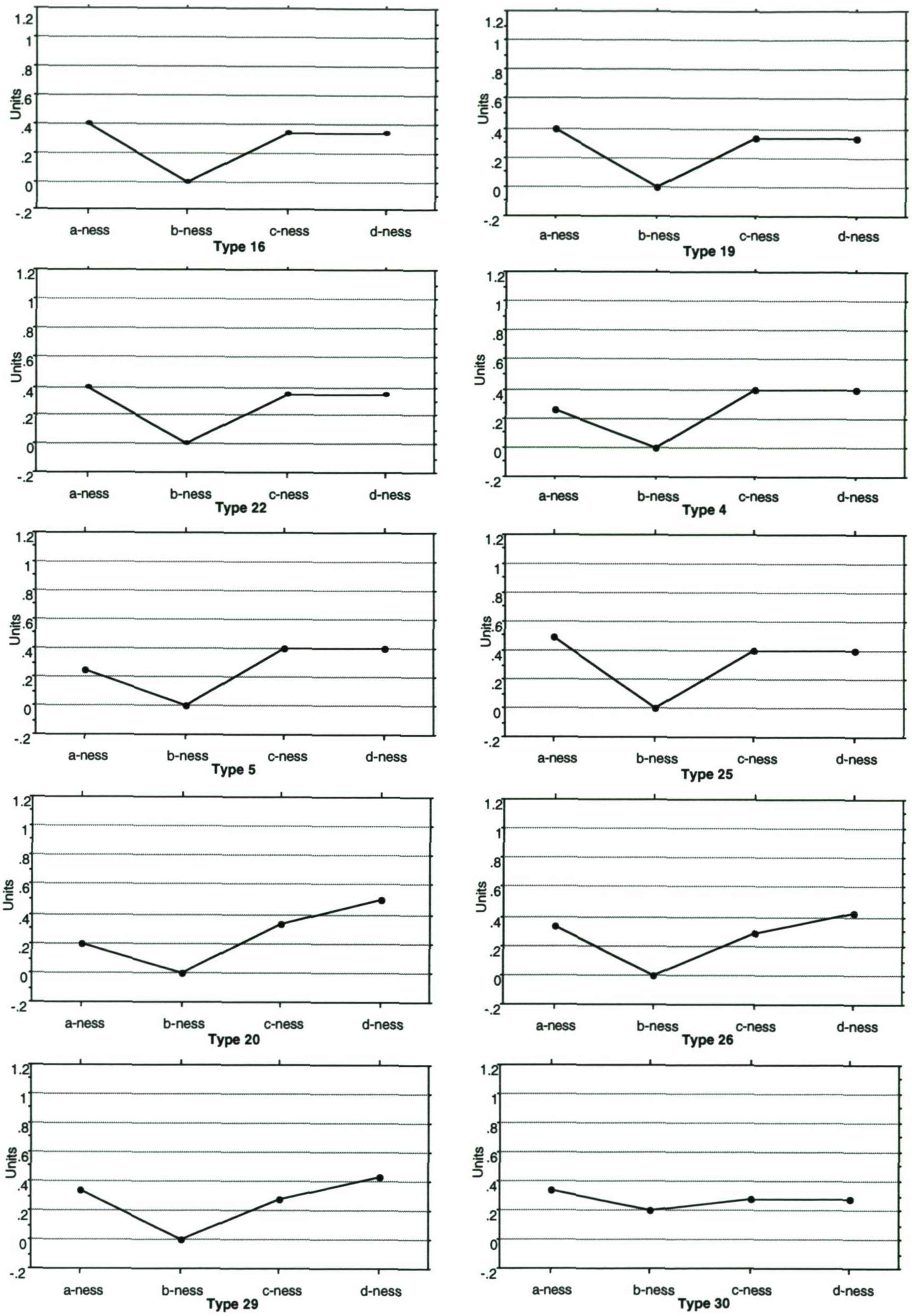


Figure 3.15. Space-type profiles: 'v-shape' profile

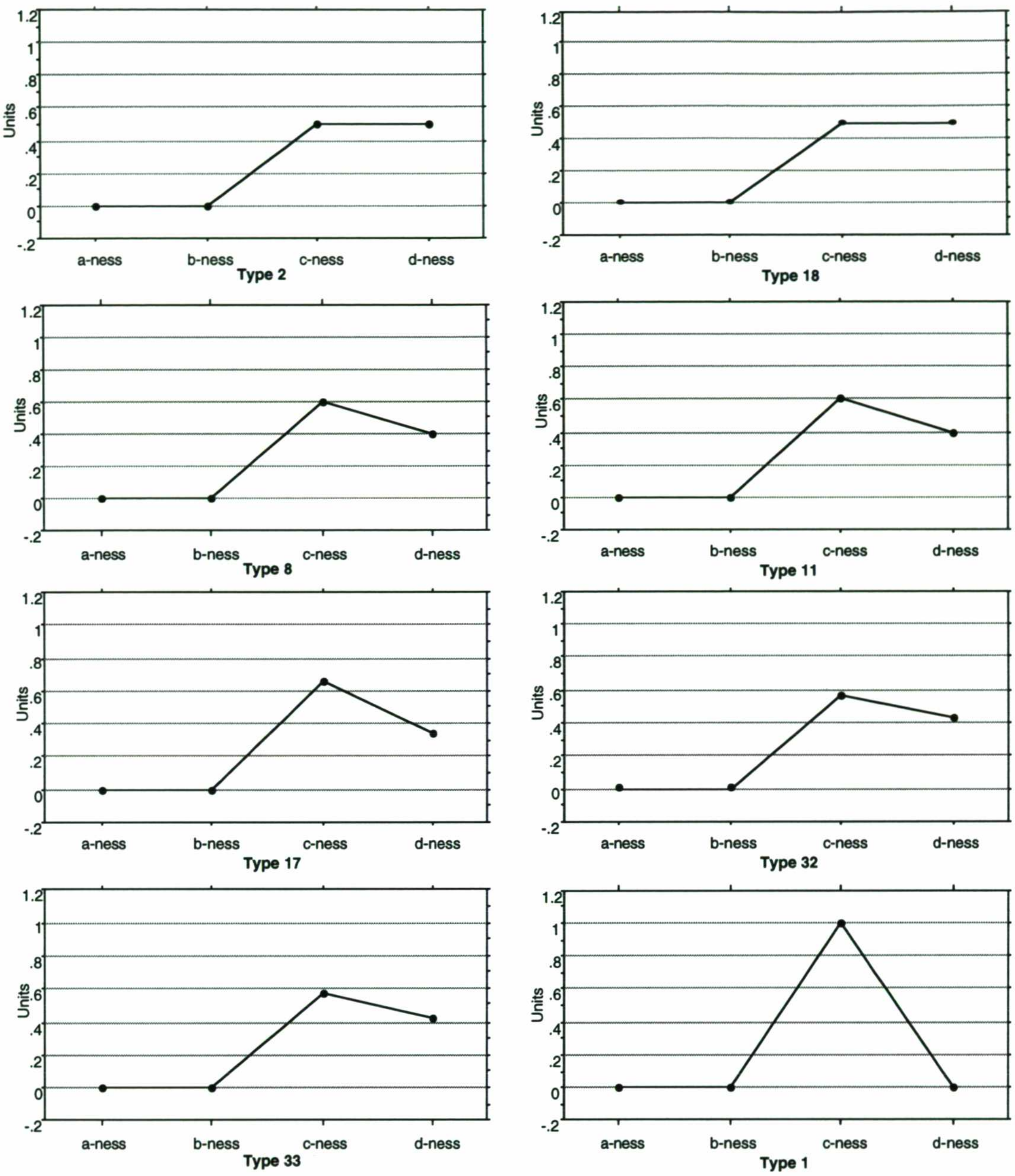


Figure 3.16. Space-type profiles: 's-shape' profile

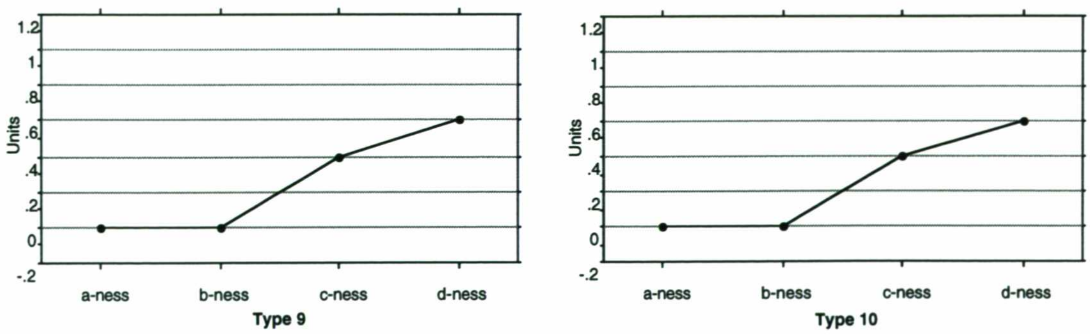


Figure 3.17. Space-type profiles: 'j-shape' profile

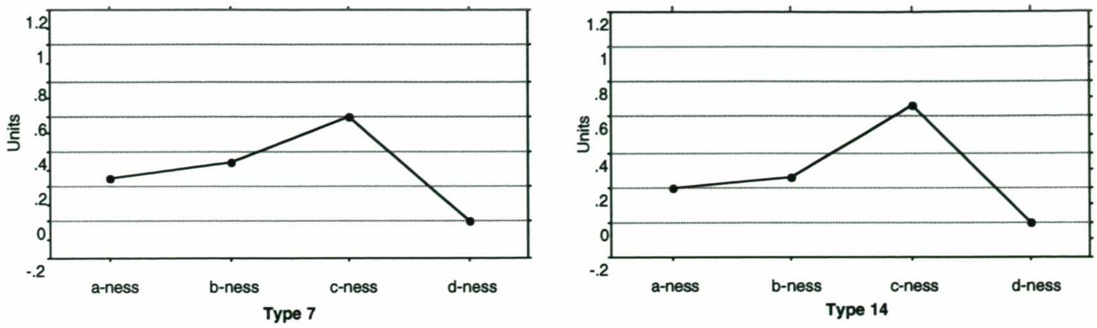


Figure 3.18. Space-type profiles: 'inverted-v' profile

The graphs are found in seven different profiles. The 'inverted-v' profile (figure 3.18.) is found in two graphs (T7 and T14), but is extremely popular within the sample, with fifty seven occurrences (27.94%). This is because graph T7 is the most popular arrangement amongst the sample. The profile presents, on average, a significant DV of 2.21. The 'v-shape' profile (figure 3.15.) is found in ten graphs (T4, T5, T16, T19, T20, T22, T25, T26, T29 and T30), but occurrs in sixty nine dwellings (33.82%). On average the 'v-shape' profile is the least differentiated (1.48), apart from the 'linear' profile (T23), which its DV value, 0.97, is the only to stay below the limit of high/low degree of differentiation (1.00). The 'sinusoid' profile (figure 3.14) is found in ten graphs, but it is not found to be as popular as the previous profiles (twenty four houses). The 'sinusoid' profiles are on average significantly differentiated (2.43), ranging from 1.64 (T31) to 3.05 (T6 and T12) The 'j-shape' and 's-shape' profiles (figures 3.16. and 3.17., respectively) present high average DV values (2.50 and 2.40, respectively). The 'j-shape' profile is found in the symmetrical graphs T9 and T10, corresponding to 4.90% of the sample, whereas the 's-shape' profile is diffused amongst eight graphs of different sizes and configurations (20.59%). Graphs T1 and T2, have four nodes; T8 and T11, five nodes; T17 and T18, six; and T32 and T33, seven.

Two unusual or isolated cases are found. These are the 'linear' T23 and the 'u-shape' T24 graphs (figure 3.13.). Their unusualness is expressed not only in their exclusiveness, but in the low DV of 0.97 for the 'linear' profile and in the relatively high DV of 2.73 for the 'u-shape' one.

It is known that there are one hundred and twenty forms of combining four space-types with five inequality signs (=, <, >, ≤, ≥), and the sample provided only seven typical profiles. This result indicates how consistent the composition of the graphs is. Moreover, this consistency is even strongly registered if the linear and u-shape profiles, which are found in one case each, are not considered, thus reducing the number of significant inequalities to five. Nonetheless, the variety of space-ness values and the substantial degree of c- and d-ness throughout the sectors' graphs is undoubted. Within the range of space-ness values, the typical order of occurrence is *b<a<d<c* (figure 3.19.), which inverts the order found in the sub-sample of architect's houses *b<d<a<c*. This average pattern confirms the ringiness of the arrangements.

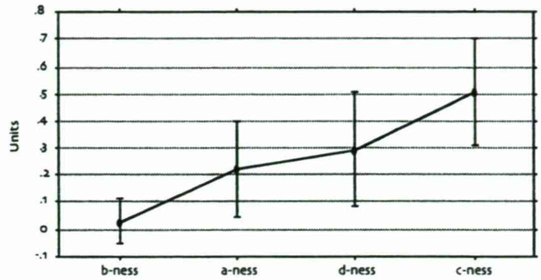


Figure 3.19. Genotypical space-ness order

3.2.3. Depth analysis

Depth value counts the number of steps from the exterior, i.e., from the street, to access each sector, therefore representing the relative distance of each sector from an stranger's viewpoint. Figure 3.20. plots the depth values presented in table 3.1., isolating the main sectors in one graph and the secondary ones in the other.

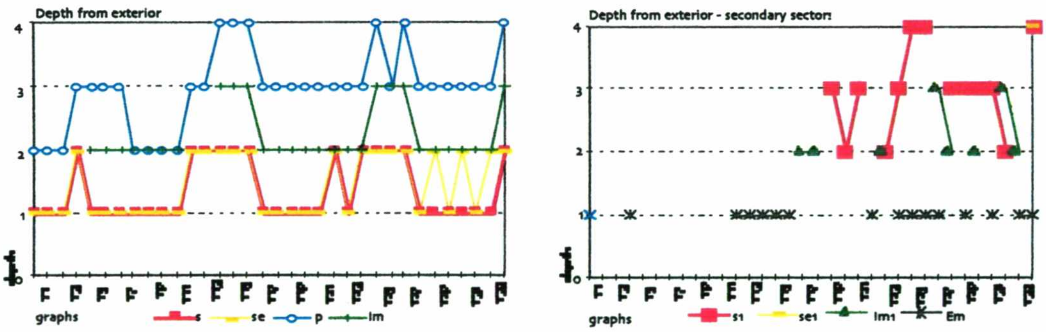


Figure 3.20. Depth from the exterior: a) main sectors, b) secondary sectors

Social and service sectors are the shallowest functional sectors in every graph, with an average of 1.35 and 1.44 steps from the street. They are always at the same distance from the visitor's viewpoint, with the exception of graphs T29, T31, and T33, where service is deeper than social, due to an exterior mediator unit. As exceptional cases, these graphs correspond to three dwellings. Another unusual arrangement is seen in Rosa Borges House (figure 3.21.), represented by graph T34, which has two service nodes, one representing the servants' quarters and laundry (se), and the other the kitchen and storage facilities (se1). Even if the kitchen is deeper, the servants' quarters have a direct access from the exterior, thus following the same trend presented by the majority of arrangements. Providing shallow service zones seems to be so fundamental in these dwellings that, even in a narrow terraced house, all efforts are made to offer double and independent entrances to the house.

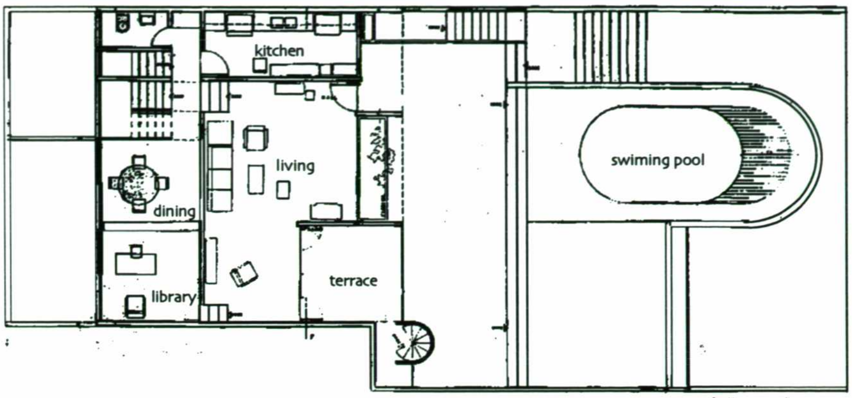


Figure 3.21. Rosa Borges House (M160), 1969: ground-floor plan

In contrast to the shallow social and service sectors, the private zone is found either as the deepest or amongst the deepest sectors (mean depth of 2.97). Its depth value varies from two (26 cases) to four (29 cases), but it is mostly three steps from the exterior (139 cases). This seclusion is resulted from the strict access to private areas through indoor spaces. It seems that access to the open air is only provided when visitors' access is denied, or when extroversion is assumed. In the first case, private verandas in multi-storey houses, and enclosed gardens in ground floor ones, are common solutions to assure seclusion and openness for the bedrooms. Berinson (M130) (figure 6.8.) and Travassos (M172) (figure 3.22.) houses are typical examples. In the second case, shallow private sectors are found when direct access to social and service areas are introduced. This is mostly achieved by opening up bedrooms to outside gardens and terraces. Some of the architects' houses showed how this is possible (Svenson and Domingues houses).

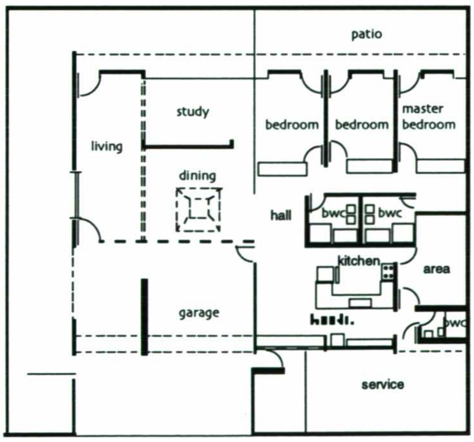


Figure 3.22. Travassos House (M170), 1970

The mediator sector, as expected, is found as a 'lock' (Chermayeff & Alexander, 1963) guaranteeing secrecy for the private zone. Its mean depth from the exterior is 2.25, staying between the social-service sectors and the private one. Secondary mediator sectors, when introduced, present similar patterns (mean depth of 2.25). As depth maximisers, mediator sectors are the means to assure seclusion and hierarchy from the public zone (street) to the semi-private one (living areas), and then to the private zone (bedrooms).

Secondary sectors also present a different depth pattern when compared with the main ones. Secondary social and service sectors are deeper than the social and service sectors, being mostly three and four steps from the outside, with an average of 3.00 and 4.00, respectively.

Summing up, the sample shows a consistent depth pattern. Access is allowed through social and service sectors, then movement is distributed and controlled by mediator spaces, and the private sector is the deepest element of all (figure 3.23.)

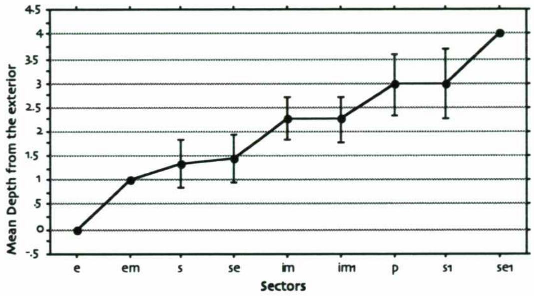


Figure 3.23. Mean depth from the exterior

3.2.4. Integration analysis

Table 3.6 shows the rank order of integration of all sectors, ordering the RRA values, from the most integrated (lowest values) to the most segregated (highest values). Some properties found in the sub-sample of architects' houses are extensively repeated. First, the 'mobility' of the mediator sector, being found either at the extremes of the rank or at its middle ranges. Second, there is the tendency to find social and service sectors at the higher spectrum of the integration values, as well as the private sector and the exterior at their lower bands.

Social, service and private sectors are the only functional sectors to be found in every single graph. Internal mediators and external mediators follow them (163 and 43 cases). Secondary sectors appear on fewer occasions: the social 1 in twenty four cases, the internal mediator 1 in nineteen cases and the service 1, in a single dwelling. Isolating the most cited sectors gives the opportunity to study how these main functional groups are related to each other. Consistencies in the order of integration of these functional sectors would indicate genotypical formulations, however phenotypical the form they may assume. The rank order of integration of the social, service and private sectors are plotted in figures 3.24.a. to 3.24.c.

Table 3.6. Rank order of integration

Rank Order of RRA - All sectors															
	s		se		p		e								
T1	0.999	=	0.999	=	0.999	=	0.999								
	s		se		p		e								
T2	0.000	=	0.000	<	0.990	=	0.999								
	s		se		e		p								
T3	0.000	<	0.999	=	0.999	<	1.999								
	s		se		em		p		e						
T4	0.473	=	0.473	=	0.47	<	1.420	<	1.893						
	s		se		m		e		p						
T5	0.473	=	0.473	=	0.473	<	1.420	<	1.893						
	m		s		se		e		p						
T6	0.473	<	0.946	=	0.946	<	1.420	<	1.893						
	s		m		se		e		p						
T7	0.473	<	0.946	<	1.420	=	1.420	<	2.367						
	s		se		p		m		e						
T8	0.473	=	0.473	<	0.946	=	0.946	=	0.946						
	s		se		m		p		e						
T9	0.000	<	0.473	=	0.473	<	0.946	=	0.946						
	se		s		m		p		e						
T10	0.000	<	0.473	=	0.473	<	0.946	=	0.946						
	s		se		p		m		e						
T11	0.473	=	0.473	<	0.946	=	0.946	=	0.946						
	em		s		se		p		e						
T12	0.473	<	0.946	=	0.946	<	1.420	<	1.893						
	s		em		se		p		e						
T13	0.473	=	0.47	<	0.946	<	1.893	=	1.893						
	s		em		se		m		e		p				
T14	0.57	<	0.859	<	1.15	=	1.15	<	2.005	<	2.292				
	s		se		m		em		p		e				
T15	0.859	=	0.859	=	0.859	=	0.859	<	2.005	=	2.005				
	s		se		m		em		p		e				
T16	0.573	=	0.573	<	0.859	=	0.859	<	2.005	=	2.005				
	s		se		m		m1		p		e				
T17	0.573	=	0.573	<	0.859	=	0.859	<	1.146	=	1.146				
	s		se		m1		m		p		e				
T18	0.286	<	0.573	=	0.573	<	0.859	<	1.146	=	1.146				
	m		s		se		s1		p		e				
T19	0.286	<	0.573	=	0.573	<	1.432	=	1.432	=	1.432				
	s		m		se		s1		e		p				
T20	0.286	=	0.286	<	0.573	<	0.859	<	1.146	<	1.432				
	m		s		se		s1		p		e				
T21	0.286	<	0.859	=	0.859	<	1.43	=	1.432	=	1.432				
	em		s		m		se		e		p				
T22	0.286	<	0.573	=	0.573	<	1.146	<	1.432	<	1.719				
	s		se		m		m1		e		s1		p		
T23	0.392	<	0.588	<	0.785	<	0.98	=	0.981	<	1.373	<	1.96		
	m		em		s		se		s1		p		e		
T24	0.196	=	0.392	<	0.588	=	0.588	<	0.79	<	1.177	<	1.373		
	s		se		m		em		s1		p		e		
T25	0.588	=	0.588	=	0.588	<	0.981	<	1.570	=	1.570	<	1.962		
	s		se		m		em		p		s1		e		
T26	0.392	<	0.588	=	0.588	<	0.785	<	0.981	<	1.570	<	1.766		
	s		se		em		m		m1		p		e		
T27	0.588	=	0.588	<	0.785	<	0.981	=	0.981	<	1.373	<	1.766		
	se		m1		s		p		m		e		s1		
T28	0.588	=	0.588	<	0.785	<	0.981	=	0.981	<	1.177	<	1.570		
	s		m		se		em		e		s1		p		
T29	0.392	=	0.392	<	0.588	<	0.981	<	1.177	<	1.373	=	1.373		
	s		se		m1		m		e		s1		p		
T30	0.392	<	0.785	=	0.785	<	0.981	<	1.177	<	1.77	<	1.962		
	m		s		se		em		e		s1		p		
T31	0.392	<	0.588	<	0.785	<	0.98	<	1.177	<	1.37	=	1.373		
	s		s1		se		m		m1		p		e		
T32	0.39	<	0.59	<	0.79	=	0.79	<	0.98	<	1.18	=	1.18		
	s		se		em		m		m1		p		e		
T33	0.392	<	0.588	=	0.588	<	0.79	=	0.79	<	0.981	=	0.980		
	m		s		se		em		s1		se1		p		e
T34	0.44	<	0.725	=	0.725	<	1.015	<	1.305	=	1.305	=	1.305	<	1.88

Rank Order of RRA - Main sectors								
	s		se		p	DV	cases	%
T1	0.999	=	0.999	=	0.999	0.00	3	1.47
	s		se		p			
T2	0.000	=	0.000	<	0.990	3.00	22	10.78
	s		se		p			
T3	0.000	<	0.999	<	1.999	2.00	8	3.92
	s		se		p			
T4	0.473	=	0.473	<	1.420	1.20	3	1.47
	s		se		p			
T5	0.473	=	0.473	<	1.893	1.50	40	19.61
	s		se		p			
T6	0.946	=	0.946	<	1.893	0.75	4	1.96
	s		se		p			
T7	0.473	<	1.420	<	2.367	1.33	44	21.57
	s		se		p			
T8	0.473	=	0.473	<	0.946	0.75	1	0.49
	s		se		p			
T9	0.000	<	0.473	<	0.946	2.00	7	3.43
	se		s		p			
T10	0.000	<	0.473	<	0.946	2.00	3	1.47
	s		se		p			
T11	0.473	=	0.473	<	0.946	0.75	2	0.98
	s		se		p			
T12	0.946	=	0.946	<	1.420	0.43	1	0.49
	s		se		p			
T13	0.473	<	0.946	<	1.893	1.29	4	1.96
	s		se		p			
T14	0.57	<	1.15	<	2.29	1.29	13	6.37
	s		se		p			
T15	0.859	=	0.859	<	2.005	0.92	2	0.98
	s		se		p			
T16	0.573	=	0.573	<	2.005	1.36	8	3.92
	s		se		p			
T17	0.573	=	0.573	<	1.146	0.75	10	4.90
	s		se		p			
T18	0.286	<	0.573	<	1.146	1.29	2	0.98
	s		se		p			
T19	0.573	=	0.573	<	1.432	1.00	8	3.92
	s		se		p			
T20	0.286	<	0.573	<	1.432	1.50	1	0.49
	s		se		p			
T21	0.859	=	0.859	<	1.432	0.55	1	0.49
	s		se		p			
T22	0.573	<	1.146	<	1.719	1.00	1	0.49
	s		se		p			
T23	0.392	<	0.588	<	1.96	1.60	1	0.49
	s		se		p			
T24	0.588	=	0.588	<	1.177	0.75	1	0.49
	s		se		p			
T25	0.588	=	0.588	<	1.570	1.07	4	1.96
	s		se		p			
T26	0.392	<	0.588	<	0.981	0.90	1	0.49
	s		se		p			
T27	0.588	=	0.588	<	1.373	0.92	1	0.49
	se		s		p			
T28	0.588	<	0.785	<	0.981	0.50	1	0.49
	s		se		p			
T29	0.392	<	0.588	<	1.373	1.25	1	0.49
	s		se		p			
T30	0.392	<	0.785	<	1.962	1.50	2	0.98
	s		se		p			
T31	0.588	<	0.785	<	1.373	0.86	1	0.49
	s		se		p			
T32	0.39	<	0.79	<	1.18	1.00	1	0.49
	s		se		p			
T33	0.392	<	0.588	<	0.981	0.90	1	0.49
	s		se		p			
T34	0.73	=	0.73	<	1.31	0.63	1	0.49

s=social; s1=social 1; se=service; se1=service 1; p=private; m=mediator; m1=mediator 1; em=external mediator; e=exterior

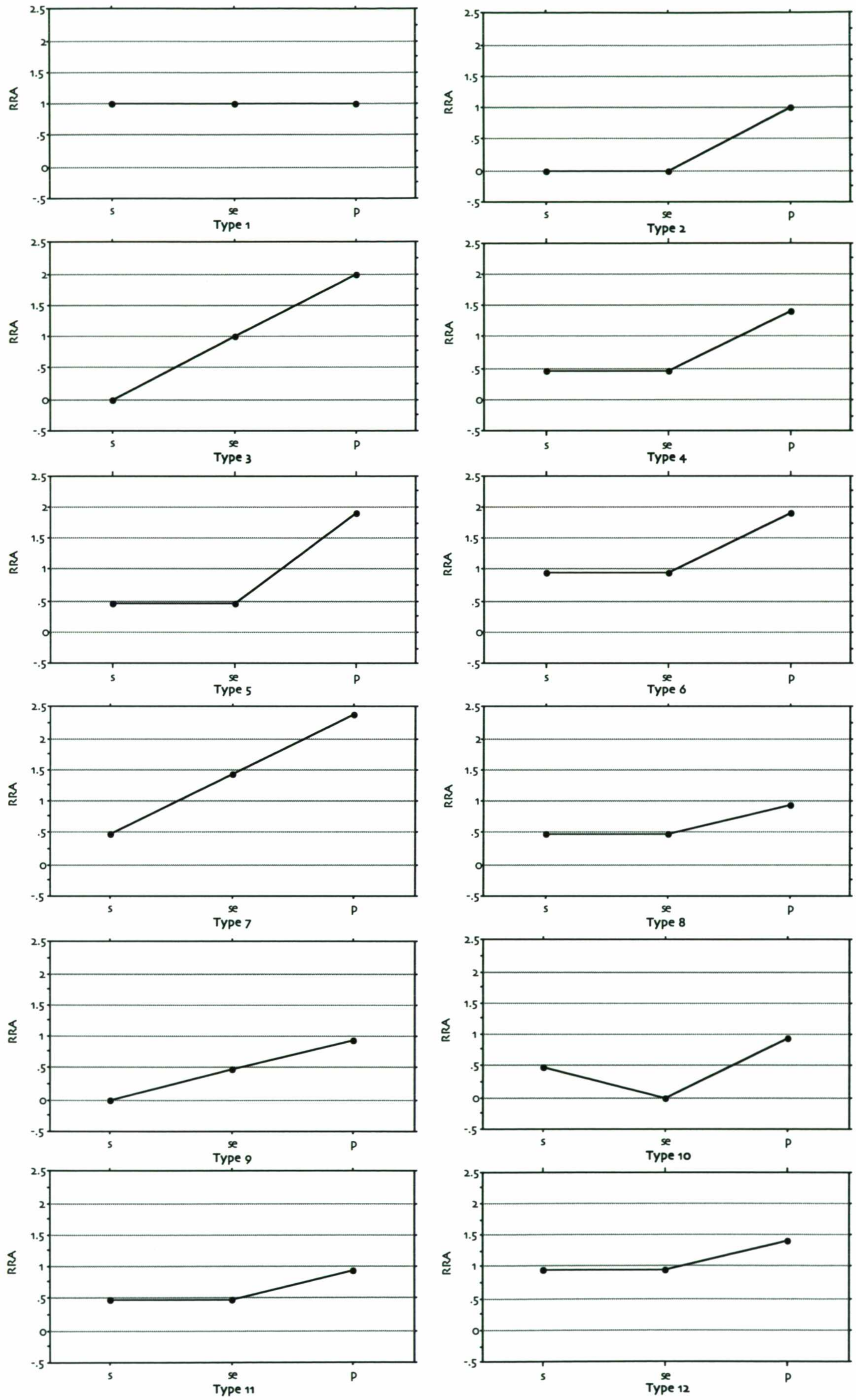


Figure 3.24.a. Rank order of integration of the main sectors

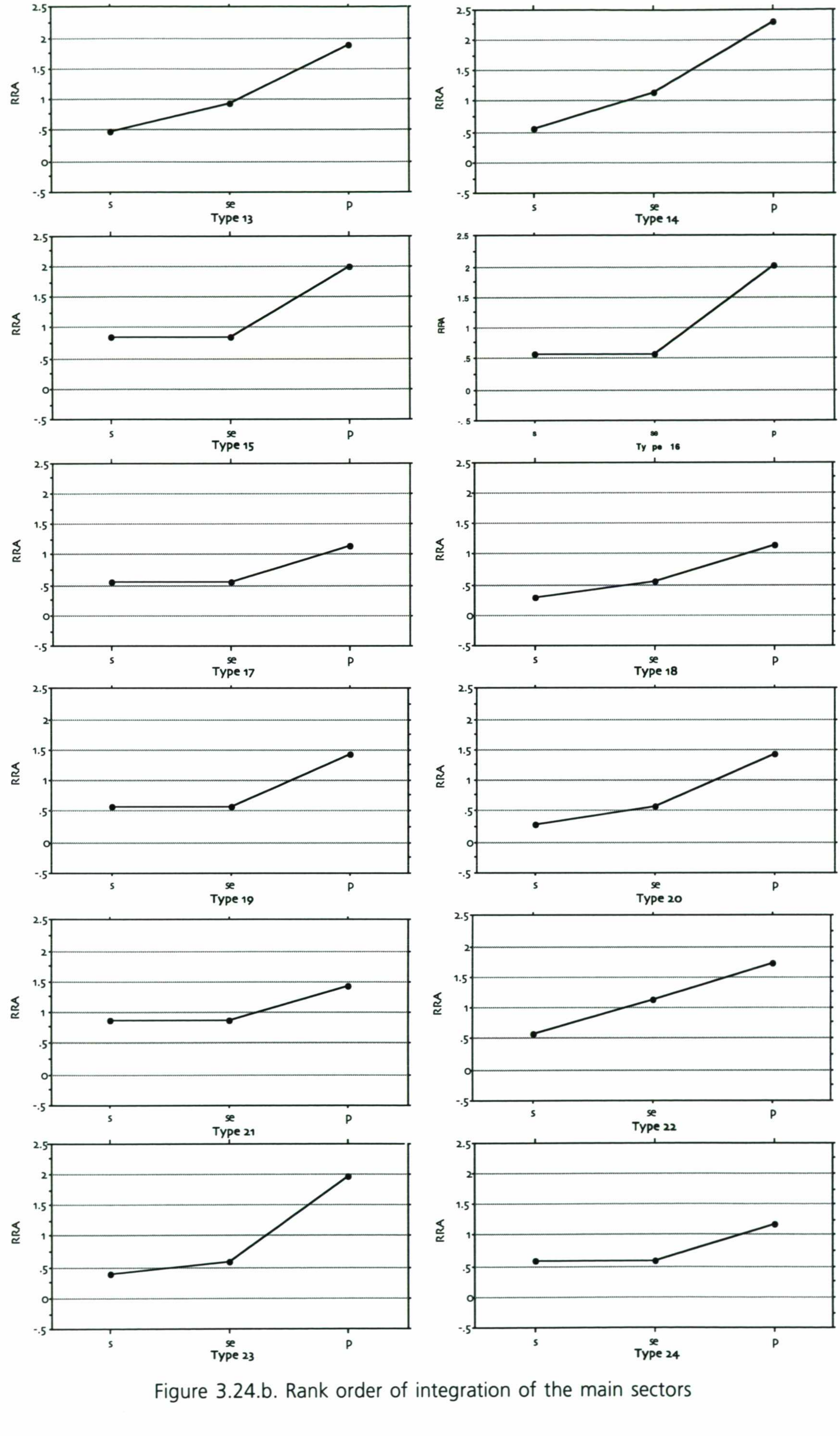


Figure 3.24.b. Rank order of integration of the main sectors

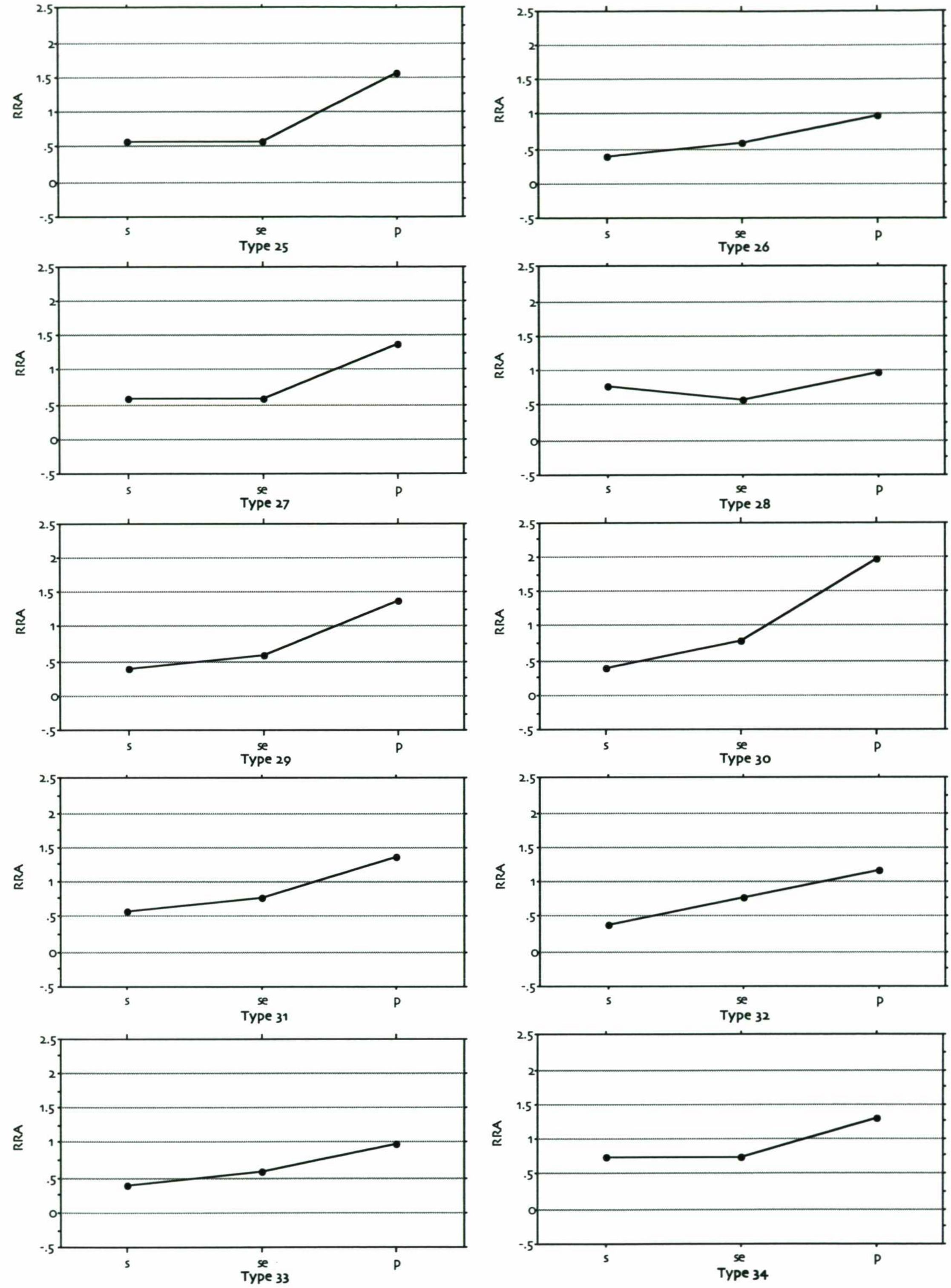


Figure 3.24.c Rank order of integration of the main sectors: graphs T25 to T34

The inequalities between the integration values form four different patterns, two of them of extreme significance for their pervasiveness amongst the graphs and the dwellings themselves. The remaining two inequalities are inexpressive in the sample, corresponding to three graphs and seven dwellings (table 3.7). The most popular inequality integrates the social and the service sectors, but segregates the private one. The genotype 1, *s=se<p* is found in

sixteen graphs, from all sizes, corresponding to 53.43% of the sample (109 dwellings). The RRA values for the genotype 1 ranges from the most integrated graph T2 (0.499) to the most segregated T16 (1.146), with a mean value of 0.961. Albeit popular, genotype 1 is weakly differentiated. Its value ranges from 0.43 (graph T12) to 3.00 (graph T2) with an average of 1.02, just above the weak/strong boundary. This low differential value results from the equal RRA values of the social and service nodes.

Table 3.7. The sectors' genotypes

Genotype 1 (s=se<p)					Genotype 2 (s<se<p)					Genotype 3 (se<s<p)					Genotype 4 (s=se=p)				
	MRRA	DV	case	%		MRRA	DV	case	%		MRRA	DV	case	%		MRRA	DV	case	%
T2	0.499	3.00	22	10.78	**T3**	0.999	2.00	8	3.92	**T10**	0.568	2.00	3	1.47	**T1**	0.999	0.00	3	1.47
T4	0.946	1.20	3	1.47	**T7**	1.325	1.33	44	21.57	**T28**	0.568	0.50	1	0.49					
T5	0.946	1.50	40	19.61	**T9**	0.568	2.00	7	3.43										
T6	1.136	0.75	4	1.96	**T13**	1.136	1.29	4	1.96										
T8	0.757	0.75	1	0.49	**T14**	1.337	1.29	13	6.37										
T11	0.757	0.75	2	0.98	**T18**	0.764	1.29	2	0.98										
T12	1.136	0.43	1	0.49	**T20**	0.764	1.50	1	0.49										
T15	1.241	0.92	2	0.98	**T22**	0.955	1.00	1	0.49										
T16	1.146	1.36	8	3.92	**T23**	1.009	1.60	1	0.49										
T17	0.859	0.75	10	4.90	**T26**	0.953	0.90	1	0.49										
T19	0.955	1.00	8	3.92	**T29**	0.897	1.25	1	0.49										
T21	1.050	0.55	1	0.49	**T30**	1.121	1.50	2	0.98										
T24	0.729	0.75	1	0.49	**T31**	0.953	0.86	1	0.49										
T25	1.121	1.07	4	1.96	**T32**	0.841	1.00	1	0.49										
T27	1.009	0.92	1	0.49	**T33**	0.729	0.90	1	0.49										
T34	1.087	0.63	1	0.49															
M	0.961	1.02				0.973	1.34				0.568	1.25				0.999	0.00		
T			109	53.43				88	42.65				4	1.96				3	1.47

Genotype 2 has the social sector as the most integrated node, followed by the service and the private sectors (*s<se<p*). It is present in fifteen graphs, varying from four to seven nodes and corresponding to 42. 65% of the sample (88 cases). On average, genotype 2 is less integrated, but more differentiated than genotype 1. Its mean RRA ranges from 0.568 (T9) to 1.337 (T14), with an average for the sample of 0.973. The difference value (DV) ranges from 0.86 (T31) to 2.00 (T3 and T9), with an average of 1.343, well above the differential boundary.

The remaining inequalities are less popular. Genotype 3 inverts the inequalities between social and service sectors, but maintains the segregation of the private node (*se<s<p*). It is found in graphs T10 and T28, and in four dwellings. These graphs are highly integrated (0.568) and differentiated (1.25). Genotype 4, does not present inequalities amongst the sectors (*s=se=p*), being found in a single graph (T1) and in 3 dwellings. Because the RRA values for each sector are the same, genotype 3 has DV equal to 0.00.

The distribution of the genotypes by social class, levels and decade is shown in table 3.8. Genotype 1 is predominant in every social class, being more popular amongst high-middle class houses. Genotype 2 is also well distributed amongst the different social substratum, being also predominant amongst high-middle class houses. This indicates that both genotypes are well embedded in Recife's society, regardless of social boundaries. It seems that sectoring the houses is as consistent, in the local community, as the form by which these sectors must be configured. Genotypes 3 and 4 are mostly found amongst middle-class houses. If these occurrences are of any significance, they indicate that experimentalism or irregularities are more likely to occur amongst the lower social substratum.

Table 3.8. The sectors' genotypes by social class, number of storeys and decades

	social class			**levels**				**decades**						
	mc	hmc	uc	grd	mez	bas	str	30's	40's	50's	60's	70's	80's
G1	43	46	20	47	4	6	52	0	1	31	54	23	0
G2	26	44	18	14	2	5	67	2	2	32	37	14	1
G3	3	1	0	3	0	0	1	0	0	0	4	0	0
G4	3	0	0	1	1	1	0	0	0	1	2	0	0

With regard to the number of storeys, genotypes 1 and 2 are found in all levels. However, genotype 2 is highly concentrated amongst the multi-storey houses. This is an effect of the deeper isolation of the private sector in differentiating the sectors even further.

The occurrence of genotypes per decade is statistically irrelevant. This is because of the irregular distribution of houses per decade. Nevertheless, it is worth noting that genotype 2 is found in all decades, whereas genotype 1 is only found between 1940's and 1970's. But the most significant aspect with regards to time distribution is the appearance of all genotypical arrangements in the 1960's. It seems that the 1960's were the experimental years, as far as functional genotypes are concerned.

The integration analysis unveiled that the sectors' graphs are genotypically composed, albeit phenotypically configured in thirty four different arrangements. These genotypes integrate the social activities and segregate the private ones. One reinforces the role of the social and service sectors in drawing the sectors' complex together. The other concentrates this role on the social sector.

These patterns are also demonstrated by ordering the average RRA values for each sector, as presented in figure 3.25. This graph reveals the average rank order of integration for the modernist houses, which is $s<se<p$. Albeit the order s=se<p is the most popular in the sample, on average the social sector is more integrated than the service sector. This distinction demonstrates the efforts on structuring the whole system around the spaces for social

interaction, and not on the operative service spaces. With this result, it becomes clear that an underlying or unconscious set of rules oriented the design of the modern houses.

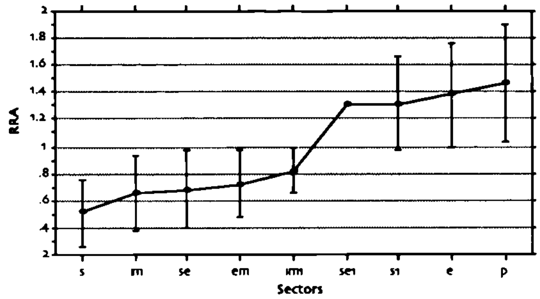


Figure 3.25. RRA values

3.3. Analysing sub-samples

Before drawing any conclusion on what kind of restrictions may have been imposed by/to the architects while designing, it may be interesting to observe how some categories of houses are particularly sectored. For example, is there any significant difference in the form by which architects design their houses and the houses for their clients? Is there any substantial differentiation in the sectors' organisation of these two categories of dwellings?

Moreover, chapter one described how the diagrammatic concept of domestic sectors was applied to the education of the modern architect and demonstrated how pervasive this concept was in providing a general understanding of how the modern house should be planned amongst the professionals involved in housing design. For this reason, engineers' and draftsmen's housing design were also of interest in order to evaluate if the specific education of the architect defined a particular approach to housing design which would differ from the less design oriented education of engineers and draftsmen.

This section aims at analysing the sample of modernist houses through the generation of two major sub-samples or categories. The first discriminates the houses of the architects from those of their clients. The second identifies the dwellings by designer. As the collection of draftsmen houses is very small, two cases only, the investigation focus of the comparison between architects' and engineer's dwellings. The respective data for the sub-samples are presented in table 3.9.

Table 3.9. Syntactic data for the sub-samples

sub-samples	h	g	ratio	size	Integration					space-ness				
				mean	MRRA	social	service	private	DF	a-ness	b-ness	c-ness	d-ness	DV
architects	14	13	1g : 1.07h	5.43	0.86	0.5	0.688	1.508	0.724	0.2	0.056	0.548	0.253	1.865
clients	163	32	1g : 5.09h	5.26	0.96	0.43	0.751	1.760	0.602	0.22	0.087	0.514	0.257	1.581
architects	177	34	1g : 5.20h	5.27	1	0.44	0.746	1.740	0.612	0.22	0.084	0.517	0.257	1.604
engineers	22	7	1g : 3.14h	4.91	0.98	0.41	0.736	1.756	0.584	0.17	0.121	0.550	0.244	1.587
draftsmen	2	2	1g : 1.00h	5	0.918	0.287	0.573	1.645	0.416	0.100	0.125	0.583	0.250	1.826
non-identified	3	2	1g : 1.50h	5	1.2	0.47	1.104	2.209	0.593	0.250	0.222	0.533	0.133	1.406

3.3.1. The architects and their clients

It is already known from the study developed in chapter two that architects' Recife houses are individually sectored, but the larger sample of modernist dwellings presents a certain degree of repetition. Indeed, thirty four different sectors' arrangements were found, with a ratio of one arrangement for each six houses. Yet, the fourteen architects' houses included in the sample present thirteen different arrangements, confirming the higher speculative nature of architects' own houses (ratio *1:1.07*). On the other hand, the 'clients' group' of one hundred and sixty three houses is arranged into thirty two different graphs (ratio *1:5.09*). This result indicates that when designing for themselves, architects use unique forms of organising the sectors, whereas when designing for their clients they tend to reproduce typical arrangements. If not for other reason, clients' functional requirements and cultural background may have restricted architects' speculative minds.

This argument can be reinforced by observing the size, or complexity, of the sectors' graphs within the categories of architects' and clients' houses. Architects own houses present on average more complex graphs, with a mean size of 5.43 nodes, perhaps as a consequence of the individuation of the functional organisation of their houses, as suggested in chapter two. On the other hand, clients' houses are slightly less complex, with a mean size of 5.26 nodes. The difference between the two samples, as it can be seen, is not prominent, but as size of the sectors' graph is a sign of functional complexity, these results reinforce the principle that architects' houses tend to be constructed as individual animals, with precise requirements, whereas clients' houses tend to be more strongly permeated by space-function genotypes. This is a very general assumption that needs further investigation.

Significant differences are also seen in the space-type composition of the two sub-samples. Architects' houses present lower a- and b-ness values than those presented by the clients' ones, but they have higher c-ness values (see table 3.9.). Clients' dwellings, however, present slightly higher d-ness values, 0.257 against 0.253, but on average their sectors are less ringy than the architects' ones. Nevertheless, they present the same genotypical pattern of space-ness, which is *b<a<d<c* (figure 3.26). They both invest in rings to generate more choices of movement between the sectors, but the clients' dwellings seem to invest more significantly in asymmetrical sub-systems (a- and b-types).

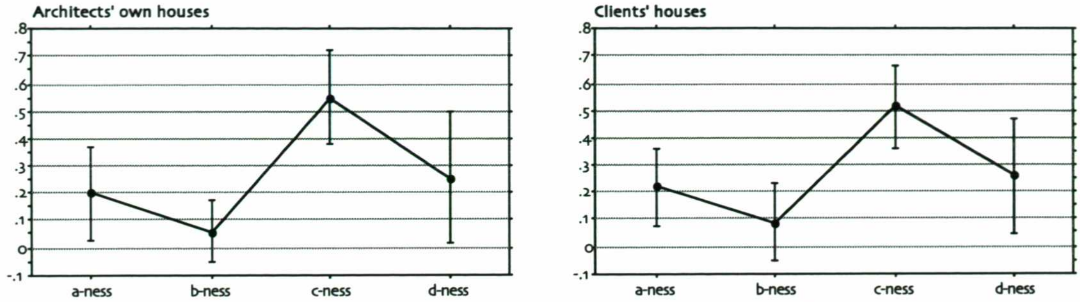


Figure 3.26. Space-ness: a) architects' own houses, b) clients houses

In terms of the pattern of integration of the sectors' graphs, architects' houses are on average more integrated than clients' houses (0.859 and 0.959, respectively), but less differentiated (0.724 against 0.602). However, the overall genotype for both samples is the same, consisting of a highly integrated social sector, followed by the service sector, and by a highly segregated private one (figure 3.27.). Curiously, clients' houses present more segregated private and service sectors than architects' own houses, but their social sectors are on average more integrated. These patterns suggest that the houses architects design for their clients define more precisely the domestic territories within the household, particularly the private sector. Conversely, architects' own houses tend to reduce sectors' topological distances, generating shallow social and service sectors. This may be an indication of a more informal way of functional organisation of the architects' houses, even though keeping the domestic territories well bounded.

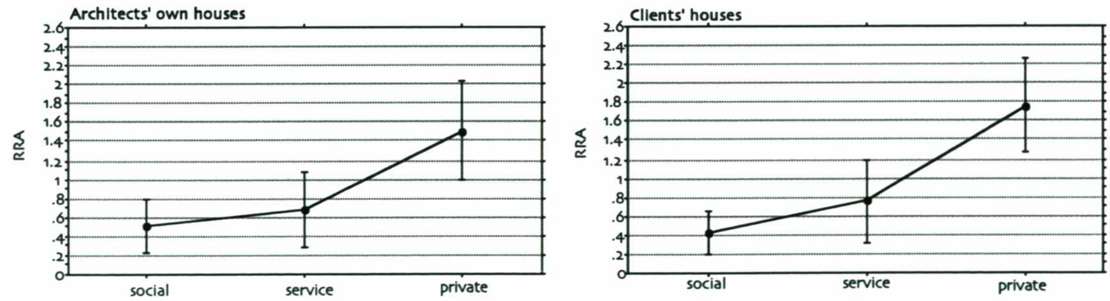


Figure 3.27. RRA: a) architects' own houses, b) clients houses

In summary, the sample demonstrates, in its limits, that architects tend to produce unique sectors' arrangements in their own dwellings with the introduction of new sectors in the household and the exploration of their possible combinations. But it also demonstrates that both sub-samples share important properties. They both follow the same overall genotypical inequality of space-ness and integration values. This indicates that over and beyond the experimental nature of architects' and clients' dwellings there are consistent patterns which perhaps identifies the typical Brazilian modernist dwelling.

3.3.2. Architects and engineers

This may be confirmed if consistent results are to be found amongst the categories of engineers and architects. The engineer's sub-sample is formed by twenty two houses, arranged in seven different graphs, generating a ratio of *1:3.14*, i.e., each graph corresponds to 3.14 dwellings. On the other hand, the architects' sub-sample is composed of one hundred and seventy seven houses, arranged in thirty four different graphs. The g:h ratio is significantly higher (*1:5.20*) than the one presented by the engineers' sub-sample, which puts into question if diversity in the sectors' arrangements is a reliable measure to indicate designers' speculative work, on the assumption that it is the work of the architect which is praised for its creative force. It may be possible that the size of the samples may have distorted the results, exaggerating the relatively high number of sectors arrangements seen in the engineers' sample. However, assuming that the number of nodes in the sectors' graph is a sign of more complex systems, the relatively smaller size of the engineers' diagrams (4.91, on average) may be a sign of a less exploratory design.

With regards to the topological composition, i.e., the occurrence of space-types in the sectors' graphs, of the sub-samples, the results show how similar architects and engineers compose topologically. The rank order of space-ness (figure 3.28.) is identical, *c<d<a<b*, demonstrating that ringiness is essential in the arrangement of both samples. Albeit the inequalities of the results generate the same ordering, the values for the sub-samples are slightly different, being the architects' houses more differentiated than the engineers' dwellings. This indicates that architects use more variety of space-type in their arrangements. However, the values are not significant enough to establish a distinction between the two categories.

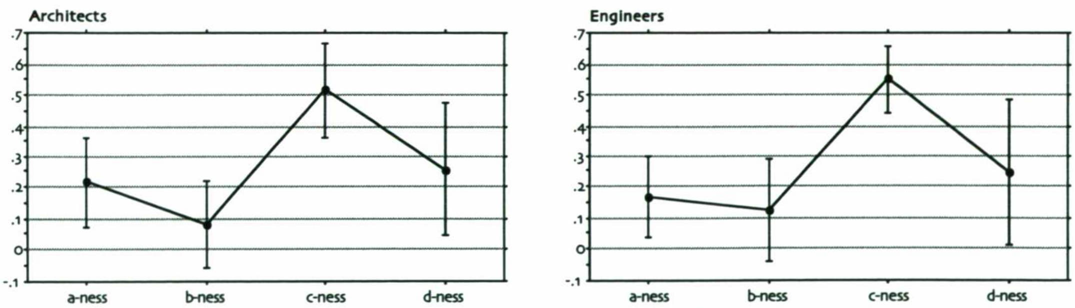


Figure 3.28. Space-ness: a) architects, b) engineers

The pattern of integration of architects' and engineers' graphs are remarkably similar. Both groups present the same order of integration, and their sector present very similar values, but the houses designed by engineers are on average slightly more integrated (0.979 and 1.003) and differentiated (0.584 and 0.612). But considering the similarities of these values, it might be assumed that as both samples present very similar profiles, both professionals zone the domestic ambience with the same rigour and similarly.

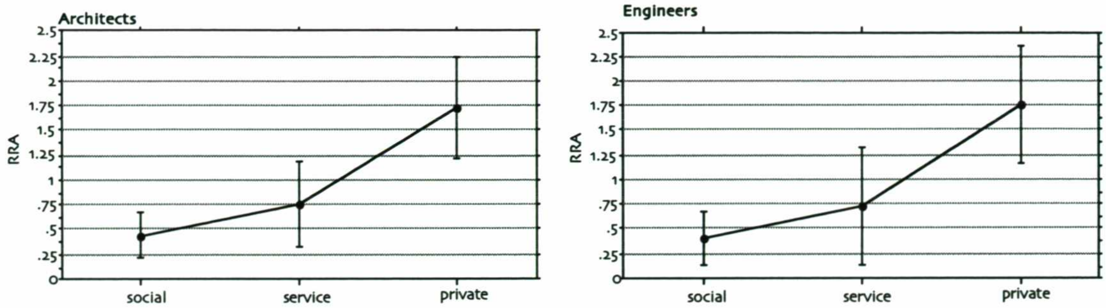


Figure 3.29. RRA: a) architects, b) engineers

This is quite important because questions the general assumption that architects are more speculative designers and that engineers tend to reproduce certain standardised layouts offered by design handbooks. Moreover, that engineers are not properly trained in the art of design, therefore lacking the necessary skills and knowledge to generate speculative buildings. This does not seem to be true, at least with regards to the sectors' organisation of the houses. On the other hand, if sectoring is understood as a preliminary and generic layer that helps designers to take control of the design process by eliminating undesirable layouts, both engineers and architects use the sectors as a preliminary form of generating solution-types to be developed and enriched while designing. Perhaps, the sectors, understood as solution-generators, do not require high skills from the part of the designers, therefore allowing a substantial degree of speculation in its forms and arrangements. Perhaps, the underlaying domestic diagrams may be so intensively permeated by cultural and social matters that it pervades through different professional categories as a consistent functional genotype. One way to evaluate the particularities of the architects' and engineers' sub-samples would be to investigate in more detail the spatial composition of the dwellings, however, this is beyond the scope of this study.

3.4. The restrictive rules

The question which was formulated in the beginning of this chapter asked if the concept of functional sectoring domestic buildings was as pervasive in the building form as it was in the architectural discourse. This chapter confirmed that sectoring was also pervasively present in houses' form by reviewing their sectors' organisation and describing their configurational properties. However, if the number of sectors' arrangements found in the sample is considered amongst the immense field of possible combinations of four, five, six, seven and eight element graphs, then it becomes clear that some sort of selective criteria must have been used to reduce the possible arrangements to the actual number of graphs found.

It is known that there are thirty eight possible combinations in a four labelled system (Steadman, 1983: pp 218-219). This number is reduced to twenty six when the mediator constraint is applied, i.e., the mediator unit has to be connected to at least two nodes. In the sample, only 3 four labelled graphs were found, corresponding to 10.71% of the total number of possible combinations. Similarly, from the four hundred and twenty possible combinations of five mediated element graphs, only ten (2.38%) were found. These values indicate that, because of the combinatorial explosion, only a diminutive proportion of the possible six, seven and eight element graphs were found. Thus, the question to be addressed in this section of the chapter is: what were the compositional rules which have restricted the number of possible sectors' arrangements to the ones found in the sample? To answer this question, a general review of the configurational properties of the sectors is necessary.

The social sector is the shallowest sector, with mean depth from the street of 1.35, and always included in a ring, but mostly in more than one ring, as a d-type space (24 graphs and 123 houses). At the same time it is the most integrated sector (mean RRA of 0.517). The social sector is also the most integrated functional sector in two hundred and three dwellings (99.50% of the sample), notwithstanding sharing this position with the service sector in one hundred and twelve dwelling (54.90%).

The service sector is also shallow from strangers' viewpoint, but with a mean depth of 1.44. It also shares with the social sector the property of being ringy, and mostly a d-type space (22 cases and 121 houses). The service sector is, however, less integrated (mean RRA of 0.685), being only the most integrated sector in one hundred and six dwellings (52.96%).

There are good reasons for the shared shallowness of social and service sectors. The social sector is the formal access, used as inhabitants' entrance and visitors' reception, and the service sector is used to guarantee secluded and independent movement for servants and vehicles. This differentiation establishes, at the limits of the dwellings, a fundamental inequality amongst servants and inhabitants, strongly embedded in the Northeast Brazil society. In this sense, double access is introduced to establish social status. But, if these inequalities are essential in structuring the dwellings, these sectors are the locus for interaction among dwellers, while entertaining, eating or cooking. For this reason, they are strongly related to each other, demanding movement and controlled operations. As places which demand local and global movements, they are c- and d-type spaces, placed in the configurational centre of the system, being shallow from every node.

Contrasting with these two sectors are the private sector and the public realm. The private sector is one of the deepest functional sectors (mean depth from of 2.97), and the most segregated of all sectors, with mean RRA of 1.456. Its degree of isolation is expressed by its predominant a-type position (19 graphs and 145 dwellings). The exterior is as segregated as the private sector, with a mean RRA of 1.384. It is also found as an a-type space, but it is predominately a c-type space (23 graphs and 177 dwellings). This is resulted from the social/service access distinction mentioned above. The similarities of these two sectors in terms of integration value suggest that, as opposite realms - private and public, they are similarly related to the main functional sectors of the house, but deeply isolated from each other.

The mediator sector presents an interesting pattern. It has a high mean integration (0.665) and its mean depth from the exterior is 2.25. Mediation, however, assumes different positions in the graphs. It seems that mediator units are introduced to differentiate configurations, either by segregating sectors, as b- and c-type spaces, or integrating systems, as d-type spaces. It appears as a c-type space in nineteen graphs, corresponding to ninety houses, as a b-type space in three graphs, but corresponding to fifty nine dwellings, and as a d-type space in six graphs, but in a reduced number of houses (14 units). This configurational behaviour of the mediator sector reminds one of the role of the joker in some card games. The joker may have different roles under the general rules of the game decided by the player. In the sectors' game, the mediator is used either to pursue further isolation or to integrate the whole system. Despite the importance of this 'joker effect', it has to be emphasised that the main purpose of the mediator sector is to increase segregation, which is expressed by its predominance as b- and c-type space.

Secondary sectors are important to create distinctiveness: for example by isolating a secondary social zone, graphs T5, T6 and T16, become graphs T19, T21 and T25. The external mediator differentiates graphs T1, T2, T3, T5, T6 and T19, for example, from the graphs T12, T4, T13, T16, T15 and T25, respectively. In all dwellings, the introduction of secondary sectors signify specific requirements, therefore clarifying their role in individualising the dwellings.

Now it is clearer how the sectors' graphs operate and how their components contribute to the configuration of the systems, it is possible to formulate their generative rules, in other words, the rules which restricted the vast number of combinatorial possibilities of arrangements of the sectors to the ones which are found in the sample of modern dwellings of Recife. They can be summarised as follows:

a- It seems that social and service sectors have to be part of a movement generator system (d-system), globally integrating the house, being equidistant from the street. In other words, social and service sectors are expected to be shallow movement generators.

b- The private sector is likely to be a deep dead-end node (a-type space), included in a ring (c-type space) predominantly to allow secluded access to the servants. In sum, the private sector is expected to group segregated occupational spaces.

c- The mediator units are used to assure seclusion for the private sector, as well as to operate the access between social and service territories. They preferably are b- and c-type spaces, which indicates that mediator sectors are used as depth maximisers.

d- It is preferable to set up the system to allow independent access from the exterior to social and service sectors, forming a shallow c-complex. Public and private domains are likely to assume opposite positions, but are equally segregated in the system.

e- Complexity in the graphs seems to be related to the complexity of the program. The larger and more complex the dwellings are, the more likely to generate complex sectors' arrangements.

3.5. The sectors' paradigm

This chapter has investigated how groups of activities and categories of household users are bound together by means of continuous networks of spaces, or sectors. It has shown how comprehensive the modern domestic milieu is sectored and how the arrangement of these sectors follows some underlying restrictive rules. It has also described how these restrictive rules reduce the possible combinations of sectors to the ones which suit dwellings' needs. Moreover, the identification of sectors' genotypes seem to confirm the hypothesis, formulated in chapter 2, that dwellings designed by architects may be genotypically organised.

The existence of such functional genotypes is a significant result. It shows that houses designed by architects may also be constricted by 'genotypes of ends', as vernacular dwellings are (Hanson and Hillier, 1979; Hillier, Hanson et al., 1987; Trigueiro, 1994; Orhum, Hillier et al., 1995; Hillier, 1996; Orhum, Hillier et al., 1996; Hanson and Elgohary, 1997; Muhammad-Oumar, 1997; Hanson, 1998). Therefore, the conjecture presented by Hillier (1996)[22] that architects' houses are essentially generated by 'genotypes of means' may be refuted, at least at the level of the sectors' organisation.

The importance of this finding allows a broader discussion on the nature of the houses designed by architects, but also on the design process itself. The nature of the sectoring phenomena may be discussed from two standpoints. Firstly, by arguing that the creation of domestic sectors is a direct consequence of a formal education based on the analysis-synthesis design method. Secondly, by suggesting that sectoring is a socio-cultural phenomenon, acting over and beyond architectural training.

3.5.1. The natures of the sectors' paradigm

As far as this study is concerned, it is possible to affirm that sectors were indeed in the minds of designers, acting as a basic layer in decision making. Moreover, the pervasiveness of the concept self-evidently associates formal education and the houses themselves. As a framework for thinking, sectoring was a paradigm.

This methodological nature of the paradigm may be argued by observing that 11.76% of the sample was designed by engineers and draftsmen whose architectural education was less formal. In spite of this, one has to realise that the discussion about how the modern house should be conceived was open to a wider public. For example, the series of columns produced by the *Instituto de Arquitetos do Brasil - Departamento de Pernambuco*, published in local newspapers under the title *Página de Arquitetura* and *Modulando*, between 1955 and 1959, publicised modernist ideas to a wider professional public. Furthermore, architectural magazines, mostly those edited in Brazil, made modern ideas and design procedures available to designers in general, and not only to architects.

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[22] For a discussion on the topic see B. Hillier, *Space is the Machine*, chapter 11, 'The reasoning art'.

The pervasiveness of such diagrammatic idea has been widely acknowledged as a modern functionalist phenomena. Some critics (Herdeg, 1983; Ligo, 1984; Colquhoum, 1985; Hays, 1992) suggest that the use of functional diagrams became, in modern architecture, an auto-referential system, meaning that buildings should be an expression of this design process. This functionalist interpretation of modernism, or at least some of its manifestations, reduces architecture to a mere consequence of its functional requirements. This line of thought has already been extensively discussed (Steadman, 1979; Anderson, 1987; Bentom, 1990; Hillier, 1996), showing that neither function can solemnly determine building form, nor that all modern architects believed this (Anderson, 1997; Segawa, 1997). Indeed, the infinite forms of human occupation, which is in process of constant change through space and time, deny the principle that buildings can be purely functional. It affirms their multi-functional nature. This is because,

no description of function, however thorough, is exhaustive of the functional characteristics of even relatively simple activities. (...) No description of function, however thorough, will automatically translate into architectural form. The more thorough the description of function, the less likely that the description will hold true even for the duration of the design process. It would be difficult if not impossible to find an artifact, simple or complex, that has not functioned in unanticipated ways (Anderson, 1987: 22).

This multi-functional nature of architecture, or better, the flexibility of plan use, has been demonstrated through empirical studies which have mapped how people use and behave in buildings (Altman and Chemers, 1984; Lawrence, 1987; Ahrentzen and Michelson, 1989; Bernard, 1993; Monteiro, 1997; Rapoport, nd). These studies advocate the variety of forms and activities performed in space, regardless of the specified range of uses prescribed by a brief or idealised by designers. These are obvious but convincing arguments to dispute a functional determinism in the generation of built forms. However, it is also obvious that function plays an important role in their design. The evidence provided by the sectors' analysis demonstrate the relevance of defining a socio-functional map of the domestic activities to shape the modernist house. Its relevance, however, does not necessarily define houses' forms. Therefore, function is not entirely dominant in the conception and life of buildings, but it does have an essential role in formulating its spatial structure. For example, as seen in chapter 2, sectoring interferes in the properties of adjacency, visibility and permeability of the houses.

However, the rules which restrict the infinite field of possible combinations of domestic sectors to the ones that fit architects' and clients' ideals point out a strong interference of social requirements. Social rules seem to have defined the precise set of suitable architectural schemes to attend the conceptions and preconceptions of house use. This is evident, for example, in the way service spaces are isolated in the household and how their occupational territories are demarcated, from the pavement line to their deepest accommodations. In fact, the classification of kinds of domestic activities into sectors and their arrangements, seems to be a function of social prejudices, rather than of the method itself. In other words, if the classification and grouping procedure guided design, social requirements ordered its process, which leads to the conclusion that the modern houses of Recife resulted from a conscious act of design to attend a very clear social and cultural intention.

This is not entirely surprising. As Hillier (1996) has shown elsewhere, buildings are the 'means by which the society as an abstraction is realised in space-time and then reproduced' (Hillier, 1996: 403). This is because society is an abstraction, though not imaginary, which is manifested and transmitted to the future through the real material word in which we inhabit. Moreover, this material world is the means by which the genotypical values which shape society are lived and reproduced daily. This concept is fundamental in his argument, because it explains why buildings, as spatial systems, are transmitters of social genotypes and not determinants of the phenotypical forms of human interaction and behaviour. Therefore, 'the act of building is (...) inevitably a social art' (Hillier, 1996: 404), and by extension, the art of design is a social act. This is why a dwelling is a '"sociogram" not of a family but of something much more: of a social system' (Hillier & Hanson, 1984: 159), and its design is a process of reification of social abstractions into material forms of social manifestation and transmission.

3.5.2. Social meaning and design process

But if sectoring is both architecturally and socially formulated, how do these two instances correlate? How are they manifested during design process? To answer these questions, it is necessary to understand how the paradigm of sectors seems to operate in design. One of the characteristics shared by the 'design methods' is the belief that, by breaking up the problem into interrelated pieces, it improves design solution. In other words, the solution of a design problem would be improved by observing the problem from its parts, analysing its requirements and conflicts, or 'fits and misfits' as Alexander (1964) prefers, and formally synthesising its optimal solution. Therefore, by following this procedure, better buildings would be generated. This design process is usually characterised as 'bottom-up' or, from its parts to the whole.

The sectoring process is one of the manifestations of this concept. For example, it observes and characterises domestic functions separately; it groups the constituent parts of the house into sectors; and it arranges the sectors to achieve the best possible performance, according to fit the requirements.

However, if sectoring had become a paradigm, the sectors' genotypes indicate that some sort of unconscious regularity, in form of the restrictive rules, has shaped the paradigmatic idea of sectoring from a global point of view. In this sense, the restrictive rules seemed to be embedded in the minds of the designers as deeply as the paradigm itself. Therefore, both design method and the restrictive rules were active in designers' minds while configuring houses' form. This indicates that classifying and sectoring processes became automated, or unconscious. Architects would think of a house as a preconceived set of functional zones to be spatially articulated according to a brief. If this is correct, the designer would previously think of a house as a compound formed by articulated sectors. The house as a whole would be preliminary in design. Therefore, design would take the form of a 'top-down' process, i.e., from the whole to its parts. In this circumstance, design becomes a dynamic process in which the whole is previously conceived and the parts are constantly adjusted to fit the preconceived idea itself, until the best solution for the problem was achieved.

The form-function problem in design has been recently addressed by Hillier (1998). He argues that, as in a configurational system any change in its parts affects the whole, the unique way to understand and deal with the form-function problem is by observing the configurational behaviour of the whole, and therefore 'in an important - though not exclusive - sense spatial design is likely to be a top-down process' (Hillier, 1998: pp 39-40). The solution of a form-function problem, Hillier concludes, is less likely to occur from the bottom-up, because it is by understanding how the whole configuration works that it is possible to evaluate if the solution to the problem was satisfactorily achieved or not.

Hillier's arguments seem to corroborate the suggested effect of sectoring in design. It seems that sectoring is one form of inducing, from top-down, the solution of the form-function problem. It allows the designer to preview, perhaps unconsciously, the configurational behaviour of the whole, while dealing with its constituent parts. The sectors serve as a basic layer which permeates design while generating preliminary solutions and allowing for their constant evaluation. When it is suggested that sectoring defines a basic layer in design, it is not proposed that design is constituted by sequential steps and once one is completed the others will logically follow. The sectors' diagram, or graph, is not the result of a frozen stage in design. It represents a topological layer which influences the overall configuration of buildings and can be revisited while design is in action, changing arrangements, reshuffling orders or adding connections.

The fundamental effect of this topological layer is to restrain combinatorial possibilities. It keeps some properties of the infinite field of possibilities steady, while structuring a complex and rich network of potential solutions. Far from restricting creativity, this process defines the limits designers need to achieve their goal. After all, design is an activity which aims for clear decisions: to design is to decide. Without imposing restrictions, one would never reach the end. And this seems to be the reason why the sectors' paradigm was so pervasive and powerful. In fact, the sector's paradigm constructs a finite field of architectural possibilities where designers are able to unfold their own architectural approach. Generating sectors may be seen as a first step towards a personal spatial style. In this sense, architectural experimentalism would be further expressed in the pattern of space-to-space accessibility and visibility, while the sectors' organisation would be a 'topological gene' of buildings, the carrier of their most fundamental spatial properties.

Another way of explaining how this 'topological gene' is manifested in design, and consequently in buildings, is by visualising a finite shape-less field, isolated from the universal field of architectural possibilities (figure 3.30.a. and b.). The component 'elements' of this field share at least one property, which is to be part of the field. These shared properties are the restrictive rules which defined the boundaries of the field. The same types of rules which have constricted the numbers and types of sectors arrangements in Recife's modern dwellings. The combinations of such elements will always keep stable the property of being part of the same field. But more importantly, these shared properties are configurationally active, in a sense which is through them that relationships between the parts and the whole are created.

There are as many finite shape-less fields as there are restrictive rules. Consequently, these fields can have their boundaries stretched, in order to include potential configurations, or shrunk, to reduce them (figure 3.30.c. and d.). The 'size' of the field determines the freedom for creation. The wider the field, the more chances to produce space solutions; the more confined the field becomes, the less chances to produce them. However as the field expands, the search for solutions becomes more and more complex, and therefore the need to keep its size under a certain dimension to make design possible. One form of addressing the power of sectoring in restricting combinatorial possibilities is how it defines adjacencies according to likeliness of functions. Grouping spaces which share or relate domestic activities into sectors eliminates potential arrangements which otherwise would be present at architect's drawing board. Moreover, it further eliminates potential arrangements by restricting connectivity between the formed sectors.

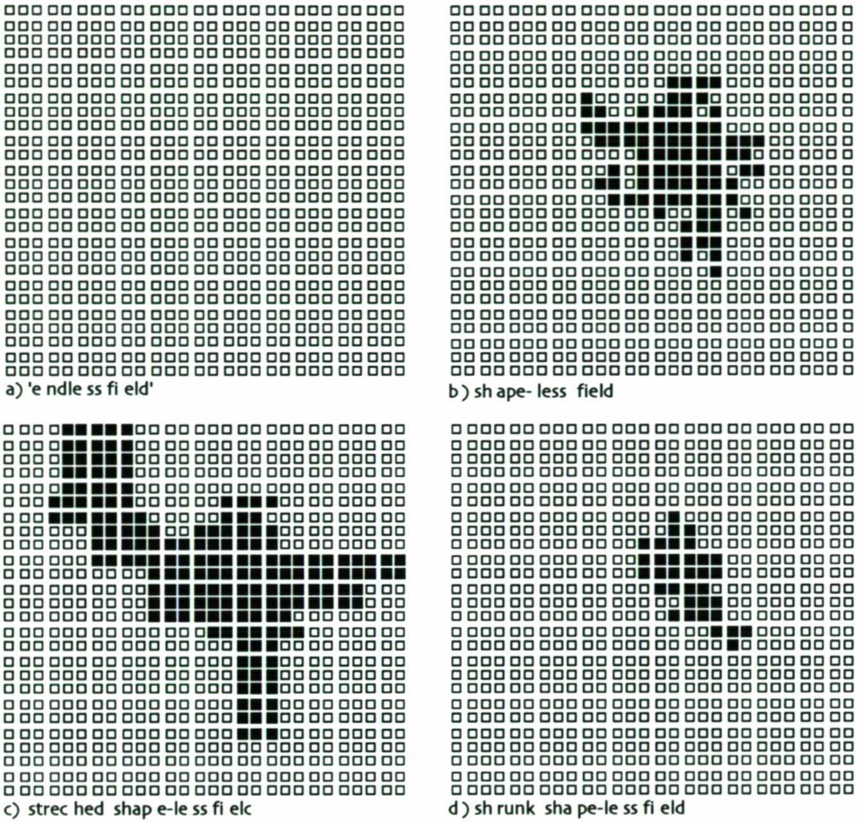

Figure 3.30. Architectural fields of possibilities and the restrictive rules

This line of argument does not put function as the singular foundation of architecture, or as its unique generator, as discussed in the beginning of this section. This line of argument does not try to classify architecture as functionalist, if extensively sectored, or non-functionalist if not. Nor does it propose degrees of functionalism, if buildings follow the ideal mediated sectors model or if they simplify it or make it more complex. What it is proposed is to produce space solutions, the finite shape-less field of possible space function solutions provides a consistent background for generating ideas. This is not a deterministic concept but a generative one. Space solutions are not only determined by attending functional problems, but are, to a certain extent, dependent on them.

Modernism was, and for many still is, much more complex and exciting than a dry functionalist attitude, as some post-modernist critics try to conclude (Jenks, 1981; Habermas, 1982). As Anderson (1987) argued, 'it was a fiction that function provided a crucial line of demarcation within modern architecture', futhermore, '(...) it is a grosser fiction to treat the whole of modernism as functionalist' (Anderson, 1987: 21). Recife architects' houses demonstrated how rich and complex they are, both spatially and formally, and should not be understood as merely functionalist buildings, despite being sectored.

The argument used here is closer to Hillier's ideas on how creative design occurs. Hillier (1996) argues that design is a configurational activity, as it establishes a structure which binds together parts to constitute a whole entity, both formally or spatially speaking. He argues that configuration is non-discursive, i.e., a phenomena that we do not know how to describe because we have unconsciously learned how to perceive it. The human mind reads and operate configurations without thinking about them, without analytically exploring them. Hillier explains how this is so by describing other non-discursive structural phenomena. Language, for example, has two levels. First, the configurational one, which is formed by its syntax and semantics, tells us how to organise words in order to express meaning. Second, we look at the words and the subject it is necessary to describe. The first level is dealt in the human mind, unconsciously. We do not meditate on the rules which govern the language when we make use of it. The second is made consciously; we think of the words and the subject in order to exchange ideas. The first is said to be non-discursive 'ideas we think with', and the second the conscious 'ideas we think of' (Hillier ,1996: pp 38-42).

This distinction between non-discursive and discursive is further developed by the author. Hillier suggests that the first is unconsciously acquired 'by creating and exploring spatio-temporal events', forming what he calls 'social knowledge'. Whereas the second, 'hold spatio-temporal phenomena steady, in order to bring the abstracts structures through which we interpret them to the surface in order to examine them critically' (Hillier ,1996: pp 40-41). This he calls 'scientific knowledge'.

Based on these concepts, Hillier constructs the fundamental difference between vernacular building and architecture. Vernacular buildings are regulated by the non-discursive aspects of configuration which makes them cultural and social objects. This is because the building process is handed through the 'ideas we think with'. The non-discursive social knowledge rules the output of the building process, through which culture is transmitted.[23]

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23 Here it is possible to trace similarities between Hillier's ideas and Glassie's concept of 'architectural competence' (from Chomsky's notion of 'competence') (Glassie, 1975). He identified in a group of

Architecture, on the other hand, brings into consciousness the 'ideas we think with', reflecting on the configurational nature of buildings, both formally and spatially. This process puts into question the process which reifies and transmits the social knowledge, and its values as well. This is why architectural design is an exploratory and challenging activity. Its output can either enhance the awareness of the social knowledge that material form is able to carry, or can challenge its values, occasionally generating new forms of non-discursive patterns. But to make this process of creative reflection on these non-discursive structures active, designers must momentarily establish some parameters or references in the field of non-discursively in order to manipulate the discursive 'ideas-to-think-of'. This process enables architects to explore form-function solutions within a well defined set of parameters and reflexively evaluate these conjectures. Therefore, it is in the 'nature of creative acts of concretion, like design, that some set of ideas to think with must be held steady, temporarily at least, in order to manipulate and experiment with the ideas the designers think of in searching the field of possibility' (Hillier, 1996: 427).

This synthetic formulation of the design process corroborates the idea that sectoring was taken for granted by architects, in order to provide the necessary space for their design conjectures. The essence of the sectoring phenomena, understood from this point of view, may be summarised by Sir Leslie Martin (1967) who argued that it is 'speculation that makes rational thought live; and it is rational thought that gives speculative invention its basis and its roots' (Martin, 1967:193). It may be true that the analytical procedure of zoning domestic activities formed the roots for the speculative creation of Brazilian modern architects.

However, it might be possible that sectoring the domestic environment, as an analytical form of dealing with the 'ideas we think with', was introduced into the level of the social knowledge. It achieved the status of a new form of non-discursive pattern, becoming unconsciously rooted in the minds of designers. Thus, sectoring became part of a steady set of 'ideas we think with'. This may be an answer for the pervasiveness of the paradigm of sectors in the modern houses of Recife. This also may explain why social values are deeply embedded in the manifestation of the paradigm in these houses.

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dwellings from Middle Virginia - USA, the use of a set of compositional rules, in the same way as rules regulate the use of language. He suggests that because this set of rules is formed by cultural knowledge shared with the community he works for, the buildings are not only bound to attend their expectations but to transmit their culture.

3.6. Looking for the origins of the restrictive rules

In sum, the sectors' paradigm is a generative idea which grounds the spatial organisation of the houses as a 'topological gene'. Its 'genetic information' is determined by the rules that have restricted the universe of possibilities to a field of actual space solutions. It becomes obvious that these restrictive rules make the paradigm operative and, ultimately, visible. But how are these rules created? Are they defined by the designers themselves or are they constituted by social practises?

The rules that have generated Recife modern dwellings were, as proposed, of social origin. Values such as family social status, class inequalities of household members and gender relations, are clearly imprinted in the rules. For example, family social status is expressed by the complexity of the graphs, whereas class inequality is expressed by the configuration of the social and service sectors. But, in what way were these social codes made implicit in the design process? If the elaboration of the sectors is dependent on social prejudices, would sectoring be more of a cultural phenomena rather than an exclusive consequence of a specific architectural ideology? Would the restrictive rules that have defined the modern dwellings of Recife be originated in a long lasting tradition, which was unconsciously incorporated by modern designers? Would it be the reason for its success?

Hillier (1998) argues that architects constructed their own spatial idiolects by creating their own ideas-to-think-with, in order to explore the field of possibilities. It is by defining networks of possible solutions that architects define their own personal styles. If designers do explore the sectors' concept as a form of keeping some of the ideas-to-think-with stable, they impose circumstantial rules according to their interpretation of the problem. This would establish the boundaries of the finite shape-less field of possibilities from an individual point of view, thus constituting the basis for a spatial idiolect.

This does not seem to be the case in Recife's sample. Its restrictive rules were culturally and socially biased, more than individually refined. It seems that social knowledge pervaded architectural design by transferring sectoring procedure and its rules to an unconscious state, i.e., to the non-discursive level of the ideas 'we think with', rather than to the conscious ideas 'we think of'. Therefore it might be possible that sectoring was previously established in the housing tradition of Recife. It is indeed possible that architectural ideology met traditional forms of domestic organisation to produce such homogeneous group of modern dwellings, particularly exemplified by their genotypical sectors' forms. On the other hand, it is also possible that the 'design methods', by extensively exploring the functional nature of the houses, and further, by engineering social behaviour, have strengthened an existing tradition in housing design. These conjectures may only be proven by observing how the houses built in Recife prior to the introduction of modern ideas were designed. The following two chapters aim at answering these conjectures. Chapter 4 introduces the reader to the social and housing panorama of Recife from the colonial period to the eve of modernism. Chapter 5 then develops the sectors' analysis of the pre-modern dwellings of Recife.

Chapter Four
Society and Space Use in Pre-modern houses of Recife

The previous chapter was concluded by considering whether the pattern of sectors' organisation found in modern dwellings originated from a cultural practice. This conjecture was formulated by the observation of how social and cultural rules were embedded in the laws that have restricted the combinations of the modern domestic sectors. The aim of this chapter is to observe how domestic activities were allocated in colonial and eclectic houses of Recife, dated from the nineteenth to first quarter of this century, and how the household members inhabited them, and therefore, test whether the modernist practice of sectoring domestic activities are based on a traditional image of how domestic environment should be.

However, the unavailability of a substantial volume of original historic housing plans makes the investigation quite daunting. The existing plans, as explained in section 4.1., are mostly originated from later surveys, representing houses' layout with significant changes in their original structures. Therefore, the main task of this chapter is to overcome this unavailability of original plans by accounting for the social lifestyle and domestic organisation of pre-modern houses, given by historical textual documents, like travellers books and personal diaries.

In section 4.2. a sample of these plans is observed and some similarities and inequalities in terms of space use and sectors' organisation of the houses is discussed. This is followed, in section 4.3., by a substantial review of descriptions and testimonies given by foreign travellers on the Recife urban panorama, its various architectural guises, and its social habits. This review is also accompanied by references to contemporary literature and more recent studies of Brazilian domestic architecture. This review of historical descriptive texts and architectural studies is complemented, in section 4.4., by an investigation of seminal sociological studies of the formation and structure of Brazilian society. This study is focused on the characterisation of family relations and their manifestations in the spatial organisation of the houses.

The chapter is concluded (section 4.5.) by arguing that pre-modern houses of Recife were organised to protect the family from the public ambience and, therefore, preserving its moral integrity. It did so by isolating domestic activities in relatively discrete sets of spaces, conforming to three domestic sectors: the family, visitors and service sectors.

4.1. On the archaeology of pre-modern dwellings

There are, however, some problems in completing this investigation. These are the lack of prescriptive texts, the reduced number of original plans, and the differences between the social structure of modern and pre-modern times. The modern houses were consistently scrutinised on the basis of theoretical and methodological documents on how modern dwellings should be. The lack of similar documents on the nature of historical houses, particularly concerning the spatial distribution of domestic activities, makes the understanding of their form-function structure more difficult. On the other hand, imposing the modernist ideal of social, service, private and mediator sectors as a model to unveil a possible sectors' organisation of Recife's historic houses would certainly lead to a mis-representation of their noteworthy character.

Another difficulty to be faced lies in the availability of architectural plans. Apart from few original drawings, most of the plans of historical dwellings were produced during a large survey carried out for the implementation of the sanitary and water supply system of Recife, coordinated by engineer Saturnino de Brito, between 1909 and 1917 (Andrade, 1997: 74; Freyre, 1975: 63). Nothing confirms that Saturnino's plans represented the original spatial features of the houses, as they supposedly were in early XIX century. It is possible that refurbishment and extensions have occurred.

Furthermore, the changes which have occurred in Brazilian society between the nineteenth century and the eve of the modernist experience make it problematic to show a clear interpretation of domestic space use and consequent classification of spaces into functional sectors. Tracing labels in historical and surveyed plans may also be misleading, because the labels registered in the surveyed plans referred to the uses at the time of the survey. Moreover, labels do not always fully express the content of the social plots they are supposed to stage, particularly in a period of fundamental changes in Brazilian society. Indeed, the end of the XIX century saw a deep restructure of Brazilian society with the abolition of slavery, in 1888, and the Republic advent, in 1889. The effect of these historical facts, particularly the end of slavery, brought enormous changes to the household structure, as Brazilian houses were very much dependent on slaves' help, as Lucio Costa explains:

The colonial and imperial Brazilian machine for living in is depended upon this mixture of thing, animal and people, that was the slave. If the remaining old houses seem to be *uninhabitable because of discomfort, this is due to slave's absence. It was he who used to keep the house running: there were Negroes for everything - from black children always at hand for messages, to the old black nanny. The Negro was the sewage, the running water in the bedroom, hot and cold; he was the electric switch and the ring bell; he fixed roof leakage and opened heavy windows; he cleaned and fanned* (Costa, 1987: 76).

The absence of the slaves in the household structure caused deep changes in the domestic environment, which later occurred in form of the eclectic suburban dwellings in their diversity of forms and styles (Filho, 1985; Lemos, 1985).

In summary, the lack of original plans and objective textual documents on the functional organisation of the colonial and eclectic houses, combined with the profound changes which occurred in Brazilian society, make the study of their sectors' organisation difficult and uncertain. One way to overcome these methodological and documental limitations is by reviewing the existing textual and iconographic documents on the nature of the pre-modern dwellings. This unveils some of the distinctive aspects of Recife's domestic life, previous to modernity.

4.2. The physical traces: typical housing plans

The first stage of this historical investigation accounts for typical pre-modern housing plans. Figure 4.1 shows the plans of typical ground floor houses found in Recife in the turn of this century. Houses *a* and *b* are colonial types, whereas houses *c* and *d* are eclectic dwellings. The colonial houses are vernacular models of Portuguese origin, which have evolved in form and spatial organisation since the occupation of Brazilian territory by the Portuguese in the XVI century. The eclectic houses were built from the nineteenth century onwards, but mostly after the consolidation of the independent Brazilian state and the cease of slavery.

One can immediately note some similarities and differences between the colonial and eclectic houses. On one hand, all houses present a clear front/back polarity. Visitors' room are shallow from the street, whereas the kitchen and slaves/servants' quarters are deep. This scheme is invariant, regardless of the orientation of the houses towards the prevailing winds and solar radiation. On the other hand, colonial houses combine thoroughfare rooms with long and narrow corridors, whereas eclectic houses abandon the use of transitional spaces.

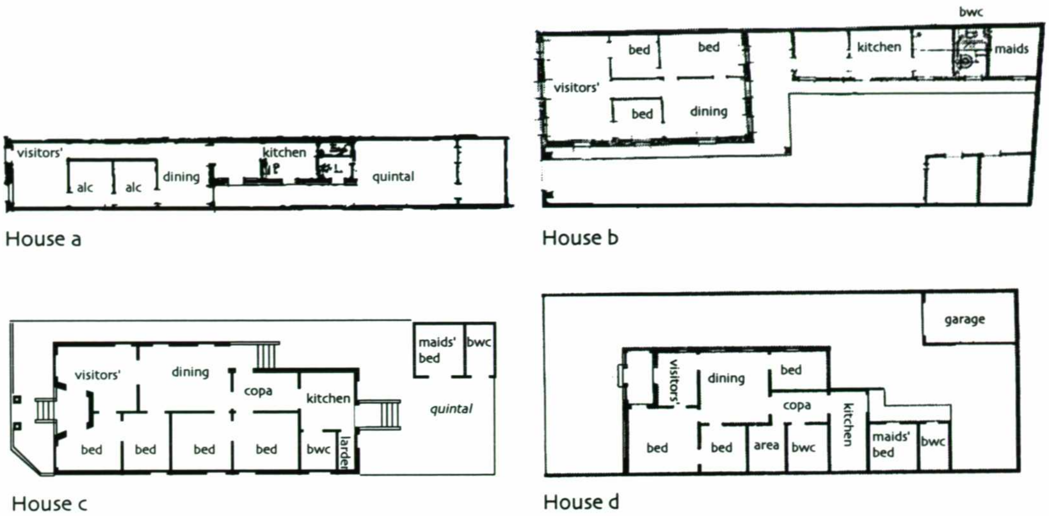

Figure 4.1. Pre-modern houses of Recife

Other features are common amongst colonial and eclectic houses themselves. Colonial houses consist of a front room/corridor/bedrooms/back room complex. This simple organisation isolates receiving and living activities in opposite areas. Eclectic houses are free from the corridor. Front and back rooms are topologically closer, and bedrooms are 'randomly' distributed in the houses. This randomness, however, seems to follow a certain logic, ruled by a bilateral symmetry generated by a longitudinal axis. The rooms for communal use are located at one side of the axis, whereas the spaces for private use are placed on the opposite side. In spite of this bi-lateral symmetry, House *d* have bedrooms at both sides of the axis.

Moreover, the permeability of the bedrooms invalidates any kind of functional sectoring, because it integrates different categories of uses and users. For example, the permeability between the main bedroom and the visitors' room, between the daily family room and the remaining bedrooms, and between the bedrooms themselves, suggest an informal way of living. In these houses, the conflict between privacy and sociality does not seem to exist, or if did, it was spatially managed in a very particular way. Perhaps the thoroughfare rooms allowed a more flexible distribution of activities. The introduction of a space-time variable would compensate the lack of a rigid compartmentalisation of space and activities.

These conjectures may be clarified by the knowledge of how the houses were actually used and how family relations were drawn. The following two sections develop this investigation. Section 4.3., describes Recife's urban life, dwellings form and space use and section 4.4. discusses seminal studies on the formation and characterisation of Brazilian society.

4.3. Descriptions, testimonies and literature: 'the world as I see'

Most of what is known about nineteenth century Recife was registered in the diaries and books written by foreign travellers, welcomed in Brazil with the opening of its ports to international transit, in 28 January 1808 (Mello, 1972). These documents, from foreigners point of view, describe the peculiarities of Brazilian colonial society, the tropical landscape with its variety of fauna and flora, which astonished most of the visitors, and the architectural scenario of its cities.

Recife was a delightful surprise for many travellers, albeit complaints about its 'disorganised' urban fabric and the dirtiness and proliferation of slaves in the streets. Positioned at the estuary of the Capibaribe and Beberibe rivers, and protected from the sea by a line of reefs (from which its name derives), Recife offered a safe site for anchoring vessels. Indeed, Recife was used as a port since the first years of Portuguese colonisation of Brazilian territory in the sixteenth century. The harbour activities gave origin to a small settlement, which later spread towards the estuary islands and the continent, and for the forthcoming centuries remained as its main economical activity.

Serving as a port for Olinda, the capital of the captaincy of Pernambuco, Recife grew slowly through the XVI century. With the Dutch invasion of Northeast Brasil, between 1630 and 1654, Recife was chosen as the capital of Dutch occupation, perhaps because of the similarities between its landscape and the Netherlands. Recife was renewed and extended to Antonio Vaz island, under the plans of the architect Pieter Post (Mello, 1987). This new settlement, Mauritiopolis, named after Prince Mauritius, the Dutch governor, was completely destroyed by Portuguese and Brazilian forces. It was later rebuilt according to the Portuguese organic fabric. In the early nineteenth century the town had already occupied the continent, growing inwards, filling the gaps between peripheral villages and sugar mills settlements, and the town centre itself. [24]

Its position was very much appreciated by travellers when approached from the sea. Henry Koster, arrived in Recife in 7 December 1809, from Liverpool, looking for a healthier climate. He described Recife's unusual landscape as he approached it from the sea:

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24 For a complete account of the urban evolution of the city through its historical maps, see *Atlas Histórico-Geográfico do Recife* (Menezes, 1988). Syntactic analysis of the urban context are also reported in other works (Loureiro and Amorim, 1994; Loureiro, Rigatti et al., 1995; Amorim, 1995a; Pessoa, 1997)

Then follows the town of Recife, with the appearance of being built in the water, so low is the sand-bank upon which it has been raised; the shipping immediately in front partly conceal it; and the bold reef of rocks on the outside of these, with the surf dashing violently against and over it, give to them the appearance of being ashore; and as no outlet is seen, they seem to be hemmed in (Koster, 1816: 2).

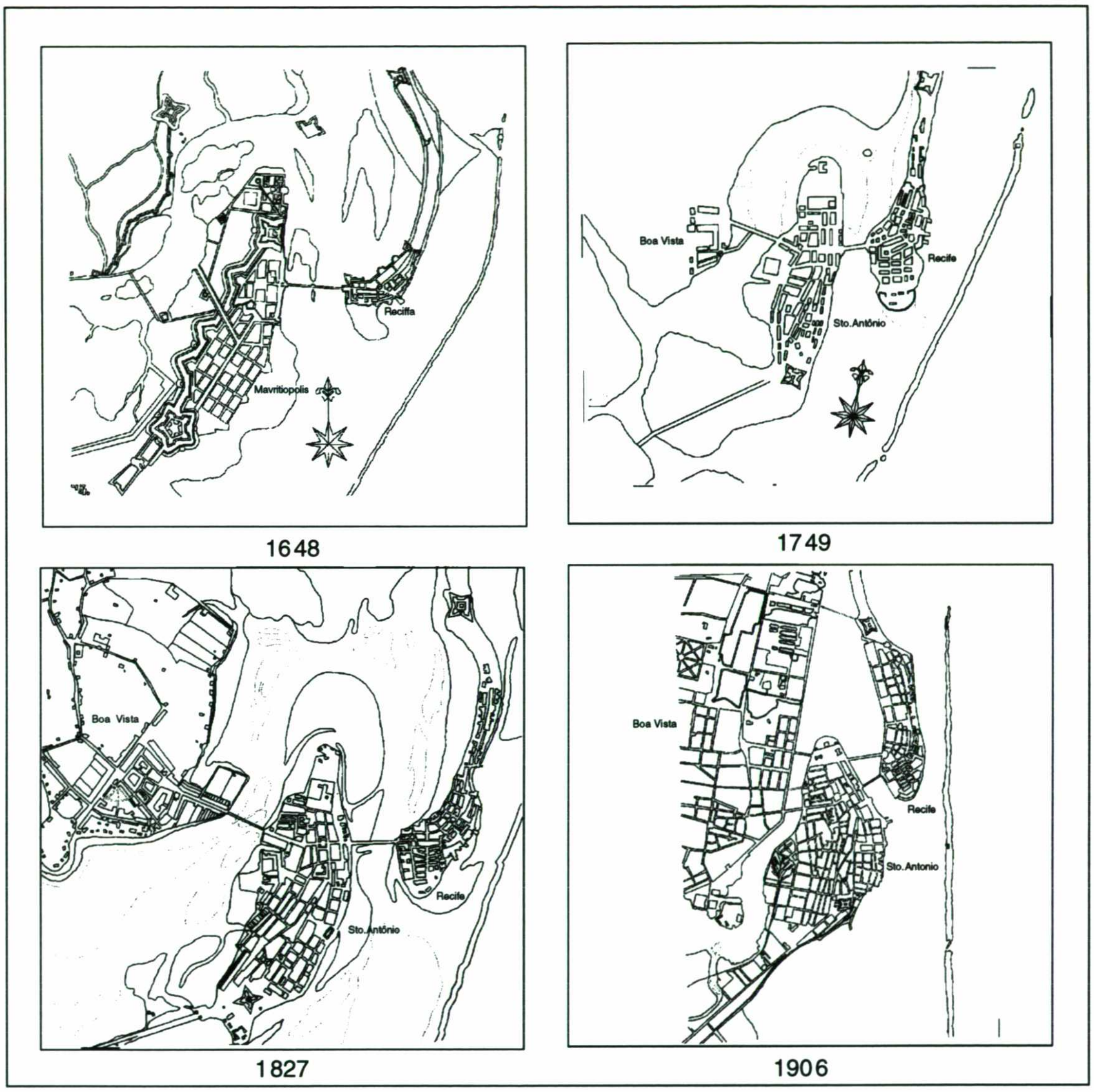

Figure 4.2. Urban evolution of Recife, after Menezes, 1988

Other travellers also expressed their reactions. Charles Waterton, who landed in Recife in 1816, commented that as 'you approach the shore, the view is charming. The hills are clotted with wood, gradually rising towards the interior, none of them of any considerable height' (Waterton, 1825: 21). To Daniel Kidder, an American missionary, Recife's whitewashed houses seemed to arise from the waves, as its terrain was almost at the sea level (Kidder, 1845). Maria Graham, arrived in Recife in the turbulent year of 1821, the city was under siege by a revolutionary army fighting for Brazilian independence from Portugal. She first landed in September 22, 1821:

(...) But no previous knowledge could do away the wonder with which one must enter that very extraordinary port. From the ship, which is anchored three miles from the town, we see that vessels lie within a reef on which the sea is perpetually breaking, but till I was actually within that reef, I had not the least idea of the nature of the harbour: the swell going ashore would have seemed tremendous, had we not been prepared for it, and made our passage of three miles a very long one. We approached the sandy beach between Recife and Olinda so nearly, that I thought we were going to land there; when coming abreast of a tower on a rock, where the sea was breaking violently, we turned short round, and found ourselves within a marvellous natural break-water, heard the surf dashing without, and saw the spray, but we ourselves were sailing along smoothly and calmly, as if in a mill-pond (Graham, 1824: pp 100-101).

Figure 4.3. View of Recife around 1847, by Bässler, after Maior and Silva, 1992

4.3.1. The urbanscape and its actors

If the natural landscape fascinated European travellers, Recife's urban context was of a complete contrast. Charles Darwin, during his celebrated travels around the world in the H.M.S. Beagle, from which observations and notes gave birth to his theory on the origin of species, landed in Recife in 12 August 1836 (Darwin, 1933: 416). The natural world was his main interest (his account for the formation of the reef is quite detailed), but he also gave his impressions of the city and its citizens:

The town is in all parts disgusting, the streets narrow, ill-paved, filthy; the houses very tall & gloomy. The number of white people, which during the morning may be met with in the streets, appears to be about in the proportion of foreigners in any other nation; all the rest are black or of a dusky colour. The latter as well as the Brazilians are far from prepossessing in their appearance: the poor Negroes wherever they may be, are cheerful, talkative &

boisterous. There was nothing in the sight, smell or sounds within this large town, which conveyed to me any pleasing impressions (Darwin, 1933: 417).

Other travellers, were more sensible to observe other aspects of the environment, looking at it from a less disagreeable perspective, outlining its urban and architectural features (Koster, 1816; Henderson, 1821; Graham, 1824; Rugendas, 1835; Tollenare, 1992). Koster describes the town, its parts and its buildings:

The town of St. Antonio of Recife (...) consists of three compartments, connected by two bridges. A narrow, long neck of sand stretches from the foot of the hill, upon which Olinda is situated to the southward. The southern extremity of this bank expands and form the site of that part of the town particularly called Recife, as being immediately within the reef. There is another sand-bank also considerable extent [sic],upon which has been built the second division, called St. Antonio, connected with that already mentioned by means of a bridge. Yet a third division of the town remains to be mentioned, called Boa Vista, which stands upon the main land to the southward of the other two, and is joined to them also by a bridge.

The first division of the town is composed of brick houses of three, four, and even five stories in height; most of the streets are narrow, and some of the older houses in minor streets are of only one story in height, and many of them consist only of the ground floor. (...)

St. Antonio, or the middle town, is composed chiefly of large houses and broad streets; and if these buildings had about them any beauty, there would exist here in a certain degree of grandeur: but they are too lofty for their breadth, and the ground-floors are appropriated to shops, warehouses, stables, and other purposes of a like nature. The shops are without windows, and the only light they have is admitted from the door. (...)

(...)The principal street of Boa Vista, which was formerly a piece of ground overflowed at high water, is broad and handsome: the rest of this third division consists chiefly of small houses, and as there is plenty of room here, it extends to some distance in a strangling manner. Neither the streets of this part of town nor of St Antonio are paved. (Koster, 1816: pp 5-7)

Figure 4.4. Recife's urban context, around 1852, by Bauch, after Maior and Silva, 1992

Maria Graham pays attention to the urbanscape but to the inhabitants as well:

The streets are paved partly with blueish pebbles from the beach, partly with red and grey granite. The houses are three or four stories high, built of a whitish stone, and all are white-washed, with door-posts and window frames of brown stone (Graham, 1824: pp 103-104). (...) *We went on shore early for the first time since the armistice. The guns are removed from the streets and a few of the shops are re-opened; the Negroes are no longer confined within doors, and the priests have reappeared; (...) I was struck by the great preponderance of the black population* (Graham, 1824: 125-126).

Tollenare, who lived in Recife in 1816 and 1817 also described the occupation of the streets by males, slaves and mulattos[25]. Businessmen gather calmly on the streets, whereas slaves move frenetically, carrying and selling goods, always cheered up by simple and monotonous tunes. To his surprise, 'white women are absolutely not seen in the streets' (Tollenare, 1992: 94). He reports the amusement of late afternoon walks by the river, where men are constantly flirted by charming mulatto women: 'I have not seen there any lady yet, but it said that they come at full moon' (Tollenare, 1992: 97). In fact, respectful women were not to be seen in such degraded environment, unless on very special occasions, for example, in family walks, always accompanied by their husbands, children and slaves; for the midnight mass, or in occasional walks, enclosed in their sedan chairs.

Tollenare report contrasts with Koster's impressions that fast changes in Recife's society were under way. These are his impressions when he returns to the city in 1811, after a short absence:

I perceived a considerable difference in the appearance of Recife and of its inhabitants, although I had been absent from the place for so short period.(...) Some new families had arrived here from Lisbon, and three from England; the ladies of the former had shown the example of walking to mass in broad day-light; and those of the latter were in the habit of going out to walk towards the close of the day, for amusement (Koster, 1816: 188).

The establishment of foreigners in the city,[26] mainly of French and English origin, certainly influenced the behaviour of local society. Prominent members of local society are reported to try to introduce these new habits to Recife's society in order to socialise with the newcomers (Henderson, 1821). Amongst them was the French engineer Louis Leger Vauthier. He lived in Recife

[25] The mulatto population was formed by the mixture between the dominant white group and the black slaves.

[26] Mello gives a detailed account of the number and origin of businessmen operating in Recife between 1845 and 1859, which includes apart from English and French, Germans, Swiss, Dutch and Danish (Mello, 1972: 18).

between 1840 and 1846,[27] invited by the President of the state of Pernambuco to take part in a artistic-professional mission (Fragoso, 1971: pp 19-20). His letters to his friend César Daily (Vauthier, 1975) together with his diary (Vauthier, 1940) are the most important documents of Recife's nineteenth century domestic architecture and social life. His astute observations portrays a patriarchal society encapsulated in family values and the isolation of women from social life.

There was, however, a period during which the tight social restrictions were relaxed. The formality of the urban and domestic lives, constituted by a strong repressive social space with little or no privacy for individual expression, was broken during the summer months. At this period the population moved to the countryside to enjoy the good weather, the river banks and a more relaxed environment. The most delightful summer retreats were to be found in the Western villages of Monteiro, Ponte D'Uchoa and Poço da Panela. Koster describes the last one:

The village was quite full, not a hut remained untenanted; and, as occurs in England at watering-places, families, whose dwellings in town are very spacious and handsome regardless of inconvenience, came to reside here during the summer in very small cottages. (...) Here the ceremonious manners of the town are thrown aside, and exchanged for an equal degree of freedom (Koster, 1816: 14-15).

Similar testimonies were given by Waterton (Waterton, 1825: 22) and Kidder (Kidder, 1845:130), but also by literature, as for example in *A Emparedada da Rua Nova* [28] - The Walled of Nova Street (Vilela, 1984). The novel contrasts city and country side, showing how rich and poor became closer and families which have never the opportunity to meet in the city started long term friendships in the country villages. It was in those times when some of the fortuitous romances and adulteries described in the book occurred.

Thus, it seems that Recife's social life was polarised between the formal and repressive urban house and the less formal and more accessible country house. However, the second half of the nineteenth century saw an increasing modernisation of urban life. The Faculty of Law was transferred from Olinda to Recife (1854), the streets were illuminated by gas light (1859), intercity (1858) and suburban trains (1866) were inaugurated, along with telephone (1883). Social life was also improved with by re-opening Recife's opera house

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[27] Vauthier returned to Recife some years later for a shorter stay. This time to coordinate the reconstruction of the Santa Izabel Theatre, consumed by fire, and to built the first Brazilian pre-fabricated iron market, São José Market (Silva, 1986).

[28] The novel was originally published in 1886.

and the creation of the *Jockey Clube de Pernambuco* (1859). Cultural and educational institutes were created, like the *Instituto Arqueológico Histórico e Geográfico de Pernambuco* (1862) and the *Academia Pernambucana de Letras* (1901) (Fragoso, 1971).

It is a fact that urban life became more lively and open towards the beginning of the century. Amorim, in his visit to Recife in 1909, makes reference to a certain *Café Chic*, at Nova Street, as a point for gathering of students and intellectuals, as well as other sites like Imperatriz and Barão da Vitória streets (Amorim, 1917). The city changed, physically and dramatically, after 1911. The harbour was modernised and the old town of Recife was rebuilt mirroring Paris of Haussman. This massive urban intervention, planned by the government, substituted the decadent colonial dwellings for a business centre, in a profitable operation of repossessing cheaply and selling plots expensively (Lubambo, 1991).

The city also expanded with the occupation of the interstices of land between the summer settlements and the old town. Living in the suburbs became fashionable. The healthier and more comfortable eclectic houses were accepted as a sign of contemporary taste and modernity. From now on, the Luso-Brazilian type of house would be seen as a past to be forgotten. At least until the revival of its nationalists values in the 1920's both by historicists and modernist architects. A space of eighty years separates Darwin's unpleasant experience of a decadent town from the vision of a clean and modern 'European city' with an eclectic taste and more refined manners. However, the segregation of family life from the street has left deep scars in local culture, still felt today, in many colloquial expressions assigning bad connotations to the word 'street'.

4.3.2. The dwellings and their inhabitants

The signs of a strong isolation of the family, particularly of its female members from public life is what stands out from these historical descriptions. The protectiveness and seclusion of women in Brazilian colonial society is considered to be from two origins. The Moors, who occupied the Iberian Peninsula for centuries, left behind, not only words and architectural features, but also habits and modes of behaviour embedded deep in Iberian culture. This Moorish influence, was later reinforced by a strong Catholic fervour of duty and secrecy concerning the family unit.

Vauthier (1975) sees traces of Moorish influence in the irregular and narrow streets of Recife. He also notes their presence in the dwellings. Firstly, it is present in the secluded alcoves, the symbol of family virtues and women's reclusiveness. Secondly, the *gelosia*, a trellis used in windows and doors, and the *muxarabi*, a type of veranda enclosed by lattice wooden work, are also of Arabic cultural heritage. Waterton describes the latter as 'of a dark and gloomy appearance, (...) grated like a farmer's dairy window, though somewhat closer' (Waterton, 1825: 21). The *muxarabi* aimed at protecting the interior of the houses from the eyes of the street, but allowing inhabitants to peep out:

The curious daughters of Eve could, through the trellis or through slightly opening it, examine the passer-by, without being seen; he, in turn, would only in his imagination admire her beautiful dark eyes fixed upon him and her bosom, of rich carnation, which the décolleté blouse allowed to swell in the warm air' (Vauthier, 1975: 66).

This protected veranda was one of the pleasant spaces of these gloomy houses. It was shaded from the sun and exposed to the refreshing sea breeze. There, the water barrels were left to be cooled down and household members would perform their daily duties and spend their time in laziness (Pinto, 1975). However, the *muxarabi* was forcibly eliminated from Brazilian houses. It is said that, motivated by the fear of a hidden gun, the Portuguese prince resident in Rio de Janeiro since 1808 ordered the demolition of all shutters of main Brazilian cities (Lemos, 1978). Yet, late nineteenth century engravings portray the use of external Venetian blinds over the balconies of Recife, keeping the needed secrecy of the interior formerly given by the *muxarabi* (figure 4.5). The modernisation of the architectural shell did not alter the social codes, although Freyre argues that 'when the shutters were forcibly removed (...) it may be said that a new phase in the relations between the sexes had began' (Freyre, 1963: pp 109-110), as female members would be more exposed to public life.

Figure 4.5. Bom Jesus Street, around 1878, by Carls, after Jurema, 1952

But it is in the interior that these houses show their similarities with Arabic domestic milieu. Vauthier (1975) relates the absolute seclusion of women and the secretiveness of the family with the Moors, reinforced by slavery. Kidder and Fletcher have an interesting theory for that:

The German, the Englishman, and their descendants, have no characteristic more marked than the home-feeling.(...) The Southern European has much in his delicious climate to make him an out-of-door being. The Old Roman was one of those who lived in public. (...) Most of the nations descendent from the Romans are, like them, without the endearing associations connected with the word home. There is, however, an important exception, to this rule in the case of the Portuguese nation, which in every respect is more Roman than any living people. The home and the family exist; and doubtless the Lusitanians owe this to the Moors, who engrafted upon the Latin stock something of Oriental exclusiveness. The Portuguese and their American descendants to this day watch with a jealous eye their private abodes, and spending many of their hours within those precincts which are their castles, the home-attachments and family associations have cherished and perpetuated (Kidder & Fletcher, 1857: 161).

The secretiveness of the family also defined that cohabitation of different families, either from the same or different ranks of society, in the same house was socially undesirable, even denigrating. Therefore, every house was occupied by a single family unit and its aggregates. This fact surprised Vauthier, as this sort of cohabitation was a rule, and not an exception, in his hometown Paris.

However, the homogeneity of dwellings form and layout surprised foreigner visitors. This homogeneity can partially be explained by urban regulations, existent since 1830. The *Posturas Municipais* obliged all buildings to be aligned to the pavement in order to define a continuous and ordered setting and to follow a precise vertical modulation. The ground floor should have twenty palms' height from the sill up to the beam. The next ones should measure from the surface of the first floorboard up to the second, twenty palms, from the second to the third, eighteen palms, and from then one it should be reduced one palm per floor (Freyre, 1975: pp 8-9). These regulations, though, do not explain the similarity between floor plans because they are subsequent to some testimonies of the homogeneity of Recife's urban and domestic milieu. As Vauthier affirmed 'who has seen a Brazilian house, has seen almost all of them' (Vauthier, 1975: 37).

4.3.2.1. The domestic building types

Vauthier dedicated himself to an accurate study of the domestic buildings of Recife, written in form of a series of letters to his architect friend César Daly.

In his studies, Vauthier proposed a five housing typologies: the *sobrados* (urban terraced houses with more than one storey), mixed-use dwellings - commerce and residence (also multi-storey dwellings), *casas térreas* (ground-floor terraced houses), *casas the sítio* (country houses) and *casas grandes* (farm seats).

The *casas térreas* were occupied by common people and the *sobrados*, in its variations, by the aristocracy (Vauthier, 1975: 64). The higher the house and the wider the frontage, the higher the social position of its inhabitants. A distinction also made by Tollenare (Tollenare, 1992: pp 95-96). Despite this social differentiation, the layout of the urban houses were very much the same, characterised by a deep and narrow floor plan (varying from 4.4 to 8.8 meters wide) illuminated and aired only from its front and back rooms. These rooms are connected to each other by means of a long corridor, to which a series of alcoves are connected. This simple structure is to be seen everywhere with slight changes.

4.3.2.1.1. The sobrados *and the mixed use dwellings*

The origin of the *sobrado magro* (slim sobrado) has been of much controversy. Some scholars defend its origin from a derivation of the Dutch bourgeois and commercial narrow terraced house (Jurema, 1952; Mello, 1952). Others dispute it, by defending an 'ecological' basis for its layout, i.e., as resulting from the lack of space for construction in the narrow strips of sand of Recife (Castro, 1954; Oliveira and Galhano, 1986). Lemos does not agree with the thesis that the *sobrado* is of Dutch origin, and suggests that its solution is related to an 'odd social behaviour' and perhaps to the lack, and consequently the price, of land or even urban regulations unknown today (Lemos, 1979: 40). Whatever its origin, the *sobrado* layout seems to correspond to the requirements for the seclusion of the family life from the street. In this sense, it is possible that the limitations of land, and therefore its high price, in conjunction with the particularities of the social structure, have shaped the layout of these urban dwelling.

Vauthier describes his typologies with precision, inclusive of typical plans, sections and façades. The more modest *sobrado* is squeezed in a width of 4.50 to 5.50 meters, in two storeys and an attic (figure 4.6.). The first floor houses the main domestic activities, and the attic comprises the dining room, kitchen, ironing room and the accommodation for the female slaves. The author not only describes the architectural features of the house, but how a visitor like him would be introduced to the house. He would follow a Negro slave from the vestibule in the ground floor to the top landing of the staircase, which is enclosed by a lattice work. A hand-bell would call a female slave. A few minutes later, after confirming that the visitor can be accepted, he would be ceremoniously received by the patriarch at the front room, but not before the children and women were confined to the back of the house, locked behind the corridors' and alcoves' doors. If the visitor were allowed to go further into the house, continues Vauthier, he would find the alcoves of the family and, at the opposite side of the visitor's room, the secluded back room. This space would be the centre of the family daily life, a sort of *gynaeceum* according to the author, where children and women, concealed from 'profane eyes', would spend their lives (Vauthier, 1975: pp 37-43) .

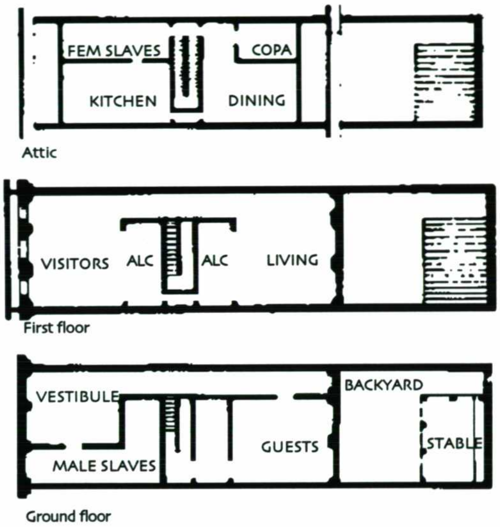


Figure 4.6. House of a respectful family, after Vauthier, 1975

A similar layout would be found in a more aristocratic sobrado. Some differences would be noticed because the plot would tend to be wider, between 6.60 to 8.80. In these houses, the corridor is central surrounded by alcoves and the staircase is developed along the side walls. The first floor is used for formal receptions and the back room is used for ceremonial dinning. The floors above, have exactly the same arrangement, which surprises Vauthier. For him, this is a sign of pure arrogance, rather than of family needs. Indeed, the repetition of the layout on the floors above is baffling, and makes one wonders if Vauthier's descriptions are faithful or not. The sheer number of alcoves in these multi-storey dwellings is surprising, and how they were used is not exactly known. Even if it is considered the gregariousness of the Brazilian family, which at some stage could include extended families and their children under the same roof, it is possible that some of the 'spare' alcoves were used for other purposes, other than for sleeping. The floor immediate above the reception is used by the family as their daily reception and dining room. It is there that a closer friend would be received and entertained. The higher the visitor goes, the less formality he/she would meet.

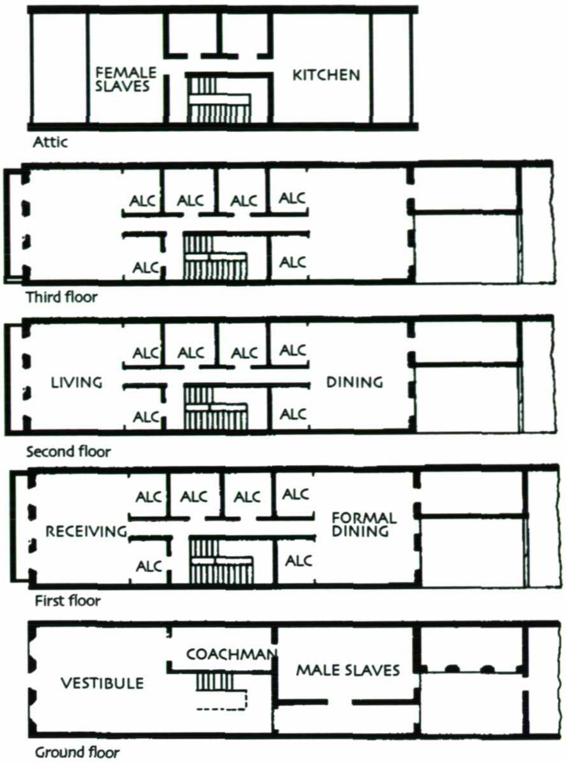


Figure 4.7. House of a wealthy family, after Vauthier, 1975

What differentiates the mixed use *sobrado* from the residential one is the arrangement of the ground floor and the first floor occupation. In the residential buildings, the ground floor is occupied by dormitories for slaves, stables and sometimes there is separate bedroom for the teenage son or guests. Aristocratic houses would have a more complex ground floor, with space for the carriage and coachman's quarters. The mixed-use house, or the 'traditional Portuguese house', as referred by Vauthier, would have its ground floor occupied either by a workshop or a tavern. The house would be accessed by a vestibule which leads to a dark central staircase. The house would be reached on two floors above, as the first floor was used for storage. The floors above that would reproduce the layout of the residential sobrado.

The *sobrado*'s form also impressed Kidder (1845). His description is similar to Vauthier's:

Many of the houses of Pernambuco are built in a style unknown in other parts of Brazil. That occupied by Mr. Ray (consul of the United States), stood fronting the water side. Its description may serve as a specimen of the style referred to. It was six stories high. The first or ground floor was denominated the armazém, *and was occupied by male servants at night; the second furnished apartments for the counting-room, consulate &c; the third and fourth for parlours* *and lodging rooms; the fifth for dining rooms; and the sixth for a kitchen. Readers of domestic habits will perceive that one special advantage of having a kitchen located in the attic arises from the upward tendency of the smoke and effluvia universally produced by culinary operations. A disadvantage, however, inseparable from the arrangement, is the necessity of conveying various heavy articles up so many flights of stairs. Water might be mentioned, for example, which, the absence of all mechanical contrivances for such as object, was carried up on the heads of the Negroes. Anyone will perceive that the liability [sic] of mistakes, in endeavouring to preserve the equilibrium of each vessel of water thus transported, exposed the lower portion of the house to the danger of a flood. Surmounting the sixth storey, and constituting, in one sense, the seventh, was a splendid observatory, glazed above on all sides* (Kidder, 1845: 120).

Smith (1975) highlights the fact that Vauthier's description fits with Luccock's description of the houses of Rio de Janeiro (similarly seen in Kidder & Fletcher, 1857: pp 162-163), and with the layout of a XVII century house built in Olinda, focus of Smith's study (Smith, 1975: pp 119-121). He suggests that these similar descriptions prove how homogeneous Brazilian domestic environment was, but more importantly how conservative it was, as the same plan layout was continuously reproduced throughout the XVII to the XIX centuries. Indeed, the presence of this vernacular type in Brazilian culture is so strong, that it is still seen today in small towns of the country, mostly in its ground-floor version (Duarte, 1997; Silva, 1997).

Smith, however, highlights the particularity of Recife's sobrados in disposing the kitchen and the dining room at the attic. The houses seen in Rio de Janeiro and in other parts of the country tended to place the kitchen at the back of the house, both as extensions or outbuildings, adjacent to the slaves' quarters (Kidder & Fletcher, 1857; Lemos, 1978). Smith suggests that the layout of Recife's *sobrados* may be of Portuguese origin, as found in William Bromley's description of the houses of Lisbon, in 1624, and James Murphy's one on Oporto dwellings, in 1789 (Smith, 1975: 121).

Years before Vauthier's arrival in Recife, Koster and Graham had the opportunity to be received in some of these houses. Their descriptions are interesting for unveiling the similarities in which social conducts are carefully rehearsed and reproduced in formal occasions, mainly when the interface between the inhabitants and visitors is constructed. The interior scenario and the ceremonial routes are to be noted. Koster describes his visit to a Brazilian family, which consisted of the father and mother, and a son and a daughter:

We went to them to breakfast, which was of coffee and cakes. Backgammon and cards were then introduced until dinner time, at two o'clock. This consisted of great numbers of dishes, placed upon the table without any arrangement, and brought in without any regard to the regularity of courses. We were, as may be supposed, rather surprised at being complimented with pieces of meat from the plates of various persons at the table. I have often met with this custom, particularly amongst families in the interior, and this I now speak of had only resided in Recife a short time: but many of the people of the town have other ideas on these maters. Two or three knives only were placed upon the table, which obliged each person to cut all the meat upon his own plate into small pieces, and pass the knife to his next neighbour. There was, however, a plentiful supply of silver forks, and abundance of plates. Garlic formed one ingredient in almost every dish, and we had a great deal of wine during the dinner. The moment we finished, every one rose from the table, and removed into another apartment. At eight o'clock a large party assembled to tea, and we did not take our departure until a very late hour (Koster, 1816: pp 23-24).

Koster recognises that the society was passing through a rapid change, however rapid those changes were, they were not noted by later travellers who were used to more 'polished' manners. However, exceptions were to be found, mostly among the wealthiest. Graham describes her visit to the house of the governor of the Province:

Our welcome was most cordial. His excellency took one end of the table, and an aide-de-camp the other: I was seated between M. and Madame do Rego. (...) The cookery was a mixture of Portuguese and French. After the soup, a dish was handed round of boiled lean beef, slices of fat salt pork, and sausages, and with this dish, rice boiled with oil and sweet herbs. Roast beef was presented, in compliment to the English, very little roasted. Salads, and fish of various kinds, were dressed in a peculiar manner; poultry and other things in the French fashion.

The desert was served on another table. Besides our European dessert of fruit, cakes, and wine, all the puddings, pies and tarts, formed part of it. It was decorated with flowers, and there was a profusion of sugar-plums of every kind. The company rose from the dining-table, and adjourned to the other, which Madame do Rego told me should have been spread in a separate apartment; but they have so recently taken possession of their house, that they have not yet fitted up for the purpose. (...) We had some excellent music. Madame do Rego has an admirable voice, and there were several good singers and players on the piano. It was a more pleasant, polished evening than I had expected to pass in Pernambuco, especially now in a state of siege (Graham, 1824: 113).

This visit was followed by a dinner with a Portuguese family. Graham confesses that she was rather curious to compare it with the local English inhabited houses:

The building and general disposition of the apartments are the same, and the drawing room only differed in being better furnished, and with every article English, even to a handsome piano of Broadwood's; but the dining room was completely foreign; the floor was covered with painted cloth, and the walls hung round with English prints and Chinese pictures, without distinction of subject or size. At one end of the room was a long table, covered with a glass case, enclosing a large piece or religious wax-work; the whole praesepia, ministering angels, three kings, and all, with moss, artificial flowers, shells and beads, smothered in gauze and tiffany, bespangled with gold and silver, San Antonio and St. Christopher being in attendance on the right and the left, the rest of the furniture consisted of ordinary chairs and tables, and a kind of buffet or sideboard: from the ceiling, nine bird-cages were hanging, each with its little inhabitant; canaries, grey finches with a note almost as fine, and the beautiful widow-bird, were the favourites. In larger cases in a passage room, there were more parrots and parquets that I should have thought agreeable in one house; but they are well-bred birds, and seldom scream all together. We were sooner seated in the dining room, than biscuit, cake, wine liqueurs, were handed round, the latter in diminutive tumblers; a glass of water was then offered to wash, and we were pressed to taste it, as being the very best in Recife; (...) The air and the manners of the family we visited, though neither English nor French, were perfectly well bred, and the dress pretty much that of civilised Europe, only that men wore cotton jackets instead of cloth coats, and were without neck-cloths; when they go out of doors, however, they dress like Englishmen (Graham, 1824: pp 127-128).

As Vauthier described, Koster and Graham were carefully taken throughout the house, from space to space, room to room, within a defined territory, above which no sound, sight or smell were to be noticed. These descriptions of Recife's social life encompasses more the life of wealthy Portuguese, Brazilians and foreign residents. Not much it is said about the lower classes' lifestyle, but the description of the liveliness and easiness of lower class Brazilians and mulattos may indicate a less formal life, and coarse manners.

4.3.2.1.2. The casa térrea

The common people lived in *casas térreas*. The *casa térrea* reproduced the layout of the sobrados. The front room was for visitors, whereas the back room was for daily use. The food was prepared and consumed in this back room, which was opened to a back yard (*quintal*) , unless when an extension housed the kitchen (Vauthier, 1975: pp 63-64). This extension became more common, with the introduction of sanitation and piped water, for both the kitchen and the bathroom.

The *quintal*, is considered by Smith as one of the most characteristics elements of the Brazilian colonial house (Smith, 1975: 121). Situated at its far back, the *quintal* did not have the formal features of the Spanish court yard. For utilitarian purposes, the *quintal* was the place for keeping the horses, for accommodating the male slaves, for the small vegetable garden, for the domestic animals, and for washing up and drying the clothes. The *quintal* housed an intense and constant activity, and it was found both in *sobrados* and in *casas térreas.*

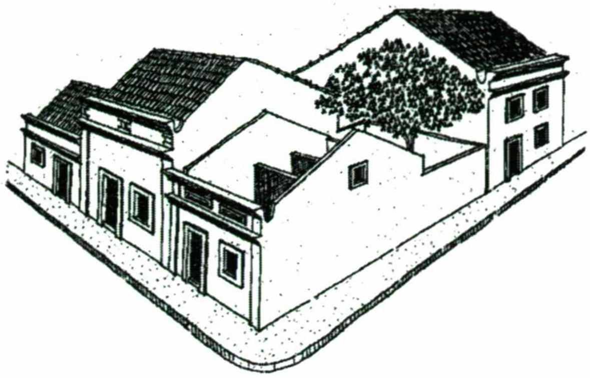


Figure 4.8. *Casa térrea*

4.3.2.1.3. The casa de sítio

The next type devised by Vauthier is the *casas de sítio*. He affirms, rather disappointedly, that the *sobrado* form is still present in these countryside houses. The layout and the overall architectural details are still mostly the same, apart from a few differences. The number of the windows on the front façade is higher, meaning that the house is wider, as more land is available. Terraces are found at the house, sometimes surrounded by balustrades. This description matches Graham's:

> *Our ride extended to Mr. S.'s country house, which is, I believe, on the same plan with all the others hereabouts, and which I can only compare with Oriental bungalow; one story very commodiously laid out, a veranda surrounding it, and standing in the midst of a little paddock, part of which is garden ground, and part pasture, generally hedged with limes and roses, and shaded with fruit trees, is the general description of the country sítios about Pernambuco; the difference arising from the taste of the inhabitant, or the situation of the ground, being allowed for* (Graham, 1824: 129).

The interior of these houses was very much the same. The familiar formal-front and informal-back rooms were separated by a row of alcoves, now illuminated and aired by means of openings in the lateral walls. The upper floors, when existed, were reserved for the privacy of the family. However, the kitchen is moved from the top floor to the back of the house, as in the *casas térreas*. It either formed an ancillary compartment or an independent outbuilding, which also housed the slaves' quarters. When compared to their urban relatives, these houses were more open; however, the secrecy of the family retreat was secured by high walls which surrounded them. As referred previously, it was the patriarchy defending itself from the street.

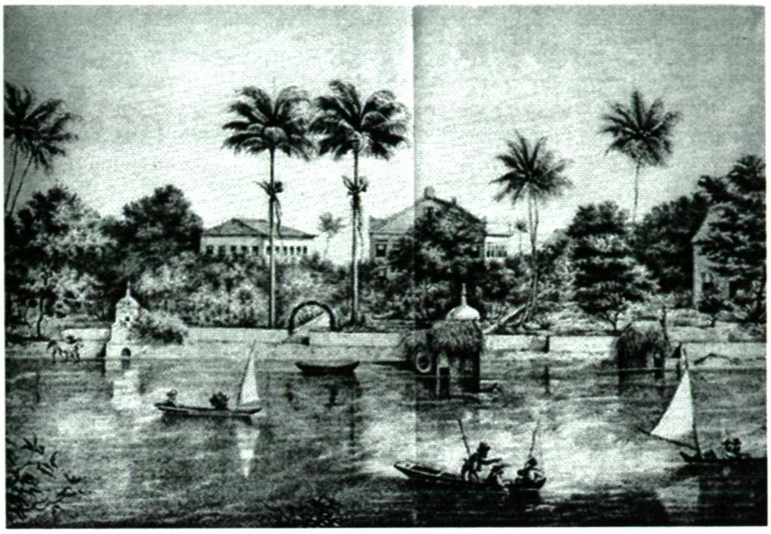


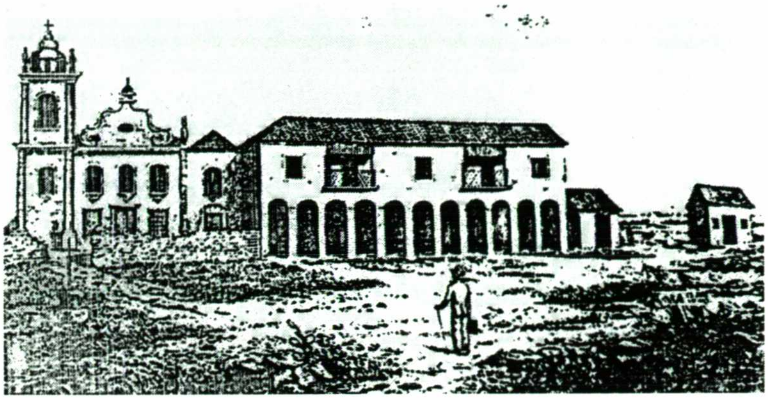
Figure 4.9. Passagem da Madalena, around 1863, by Schlappriz and Carls, after Maior and Silva, 1992

4.3.2.1.4. The casa grande

The final type, *casa grande*, is the centre of a rural complex which is composed by the slaves quarters, or *senzala*, the chapel and the sugar mill itself. It is characterised by the utmost architectural disorder (unmatching floor partitions and irregular composition of architectural elements), indicating a piecemeal construction.

Outsiders were usually welcomed in these rural areas. The complex offered special accomodation for visitors, however, outside the *casa grande*. Visitors would be received in the dining room, generally the only space opened to visitors, where the family rarely appeared on such occasions, but Vauthier attests that was not a rule.

One characteristic feature of these houses, was the *alpendre*, which surrounded the building, mostly overlooking the fields and the sugar mill. For some (Freyre, 1985), the *alpendre* represented the utmost characteristic of these houses, as the space, where the landowner would exercise its control over the complex, and served as a transition between the seclusion of the interior and the exterior. Silva (1990), in his comprehensive study on the morphology of the *casa grande*, challenges this assumption by suggesting that some *casas grandes* never had *alpendres*. However, the heterogeneity of the houses' layouts found today, mostly adapted through the passage of time, alongside with the lack of historical documents, does not allow for a complete and detailed account of their original properties.



(Figure 4.10. Torre sugar mill, after Henderson, 1821)

4.3.2.2. The eclectic fair

Travellers also observed that some of the houses built at the fringes of the city presented distinctive architectural features from the colonial *sobrado*, *casa térrea* and *casa-grande*. The Brazilian architecture renewal had different origins. Firstly, it was originated from the neo-classic values introduced by an artistic French mission, sponsored by João VI, the King of Portugal, in exile in Rio de Janeiro. The idea behind the artistic mission was to civilise or to enhance Brazilian cultural and artistic life. The mission was composed of architects, engineers, painters, art professors, sculptors, engravers, and musicians graduated from the Beaux Arts Academy of Paris.[29] The architect Grandjean de Montigny was held responsible for the organisation of the *Academia Nacional de Belas Artes*, which opened in 1826. This first Brazilian school of architecture became the centre for the dissemination of the neo-classicism in the country (Taunay, 1956; Lemos, 1979). Secondly, the immigration of more skilful workers from Europe provided the basic means for this renewal. In Recife, Francisco do Rego Barros - the provincial governor of Pernambuco, between 1837 and 1844 - organised an artistic-professional mission aiming at raising the standards of local craftsmen[30]. This mission included apart from Vauthier, the French engineers Boulitreau, Millet, Porthier, Buessard and Morel (Fragoso, 1971: pp 19-20). They were preceded by a group of workmen from Hamburg, in 1839 (Vauthier, 1975: pp 12-13). Finally, we find the creation of Arts and Crafts schools and workshops, which

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29 The mission was formed by the painters Jean Baptiste Debret and Nicolas Taunay, the sculptor Auguste Taunay, the engraver Charles Pradier, the mechanical engineer François Ovide, musician and composer Segismund Neukomn, along with the architects Lebreton and Grandjean de Montigny, the head of the mission.

30 It is also to be noted the presence of the French cabinet-maker Beranger in Recife since the 1820's, who apart from modernising stylistically and technically the furniture design, he also formed local craftsmen, very much in the principle of master/apprenticeship (Vauthier, 1975: 57).

prepared a more efficient and qualified builder. It also introduced new construction techniques and tools.

The initial predominance of neoclassicism was soon shadowed by the stylistic liberty which characterised the historicist period. The revival of historic architectural elements was a sign of modernity in the late nineteenth century. Trigueiro describes the eclectic houses of Recife and comments the fade of the colonial city:

Pointed arches, battlemented parapets, bargeboards, iron railings and stuccoed mouldings of flowery undulations or varying motifs were some of the most popular features applied to buildings which were seen as romantic in ethos and referred to as picturesque, neo-gothic, art-nouveau and God-knows-what-else in style. In the decades around the turning of the century such elements defined the appearance of houses newly-built or under construction in the recently developed suburbs (Trigueiro, 1994: pp 215-216).

Much of what had survived previous fads in terms of austere façades, from large sobrados to tiny casas térreas - already slightly touched with a tint of neo-classicism dissolved into moulded stucco. Symmetry fractured hopelessly into askew openings, steep side gables disintegrated into mansard roofs, red tiles disappeared behind indented or undulating parapets (Trigueiro, 1994: 216).

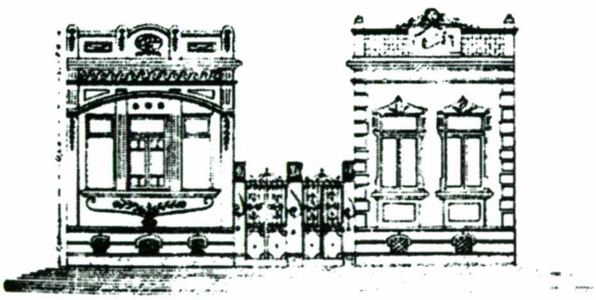

Figure 4.11. Eclectic houses, after Lemos, 1985

The changing face of the city was accompanied by a restructure of the household with the liberation of the black population from slavery. The first steps were taken with the reduction of the slaves' traffic (1850), the freedom given to newborn slaves (1871) and to the elderly slaves. The abolition of the slavery was finally conceded in 1888. The household structure had to be adapted to this new condition. The *sobrados* became a relic and needed immediate transformations, as Jurema mentions:

The abolition of slavery transformed the old sobrado into a relic, of difficult use and management. One of the first effects of the lack of slaves around and about the house was the adaptation of the kitchen to the lower floors, closer to the dining room floor, below the attic (Jurema, 1952: pp 80-81).

Notwithstanding this immediate adaptation, the growth of the city towards the continent, where larger plots were available, and the establishment of new paradigms of hygiene and lifestyle, contributed for the substitution of the colonial types for the suburban semi-detached and detached eclectic types. This process and consequent changes in the built morphology has been described in many architectural studies (Costa, 1975; Lemos, 1978; Lemos, 1979; Bruand, 1981; Filho, 1985; Lemos, 1985; Fabris, 1987; Trigueiro, 1989).

The mutations of the domestic interiors is apparent in the whole household complex; however, it is in the service areas that these changes acquired more specificity. The *sobrado*'s top-floor kitchen was moved to the ground floor with the provision of piped water and sewage system. Its size was reduced with the new coil-cooker and cooking facilities. In spite of the improvements in hygiene and cooking procedures, the kitchen remained segregated to the back of the house. The kitchen of the urban, as the territory of the servants (see figure 4.1, houses *c* and *d*). The bathroom was also introduced to the house, normally adjacent to the kitchen. Later, bathrooms were categorised for the use of servants, visitors and the members of the family, and dispersed in the building. Upper-middle and upper class houses might even have en-suite master bedrooms. Middle-class houses would have an inhabitants' and a servants' bathroom. At that time the costs for providing a full bathroom was extremely high. The nuisance to build a separate toilet for the servants, even in the simplest houses, shows family's concerns in segregating servants, but mostly the concern with personal and moral hygiene.

In the aftermath of the abolition of slavery, a new member is introduced to the household, the housemaid. Housemaids were mostly of modest origin, although in some aristocratic houses some housemaids and governesses were of European origin. These, however, were rare exceptions. To a certain extent, housemaids have substituted the slaves in the domestic environment. They performed all sorts of domestic tasks, from washing up to taking care of the infants. The conditions their were submitted to may be assessed by the position and conditions of their accommodations in the dwellings, always segregated at the *quintal*. Lemos points out that in late nineteenth century, indoor housemaids' rooms were found amidst upper-middle and middle classes of São Paulo (Lemos, 1985: 77). This is rare in the houses of Recife. Perhaps, it signals the strength of class/gender/race differentiation which characterised the patriarchal and semi-patriarchal social structures of previous centuries.

However, what seemed to be a rule was the presence of an *edícula*, or an outbuilding situated at the back of the plot. Lemos suggests that the detachment of the service spaces from the house was determined by the popularisation of the automobile. The automobile not only introduced the garage, but also transformed the garden to allow its movement through the plot. Other service rooms were attached to the garage to form the *edícula*. Lemos credit the *edícula* as a Brazilian creation, if not from São Paulo (Lemos, 1985: pp 68-74). Lemos' hypothesis on the origin of the edícula may be disputed by Vauthier's description of the casas térreas, unless Lemos relates the etymology of the word *edícula* to the appearance of the garage. Even so, these outbuildings are also present in modest residences, even without the presence of the automobile (Lemos, 1985: 77).

The *quintal* also changed with the dispersion of service spaces around it. Its connection to the kitchen, laundry, servants' rooms, servants' bathroom, storage room, and garage generated a frenetic movement of servants and women while washing up, drying clothes, cooking, preparing the food, dying cotton and fabrics for sewing, bringing goods in an out of the kitchen and taking care of the children (Lemos, 1978: 69).

The readjustment of the service complex in the post-slavery house is completed with a new space, the *copa*. The etymology of the name *copa* derives from the word used to designate the cupboard that kept goods for immediate consumption (cookies, cakes, fruits, tea, coffee) and the daily crockery. Later it was extend to label the space which separated the kitchen from the dining room (Corona and Lemos, 1972). The *copa* was first introduced in the upper class houses as a buffer space between the kitchen and the dining room. There the *copeira* servant would wash up, polish and keep the crockery. Later, the *copa* was absorbed by the lower classes in three distinctive functions. In middle class houses, it became the centre of the daily life in substitution for the dining room, which was then used for formal occasions. In these houses, the family would have their simple meals at the copa, and dinner in the formal dining room, when all the family was congregated. In more modest houses, however, *copa* was the room for all meals and also used as a living room. In other cases the *copa* became a transitional space where the old cupboard or *copa* was placed. Whichever form the *copa* may have assumed, its main effect was to isolate the service and family/visitors spaces.

Transitionality is another characteristic of some of the eclectic houses, particularly those of the upper class (figure 4.12.). Vestibules, hallways, corridors, staircases, formed a network of transitional spaces which allowed privacy of movement. According to Lemos, these houses 'had three well defined zones - service, living and resting' and the 'hall allowed movement from one zone to the other without crossing the third' (Lemos, 1985: 80). On the other hand, middle class ground floor houses did not present transitional spaces. Instead, bedrooms and living rooms were directly interconnected (figure 4.1.). These thoroughfare rooms generated secretive passages when, for example, receiving guests. In these houses, the modern domestic zones, as announced by Lemos, were not present.

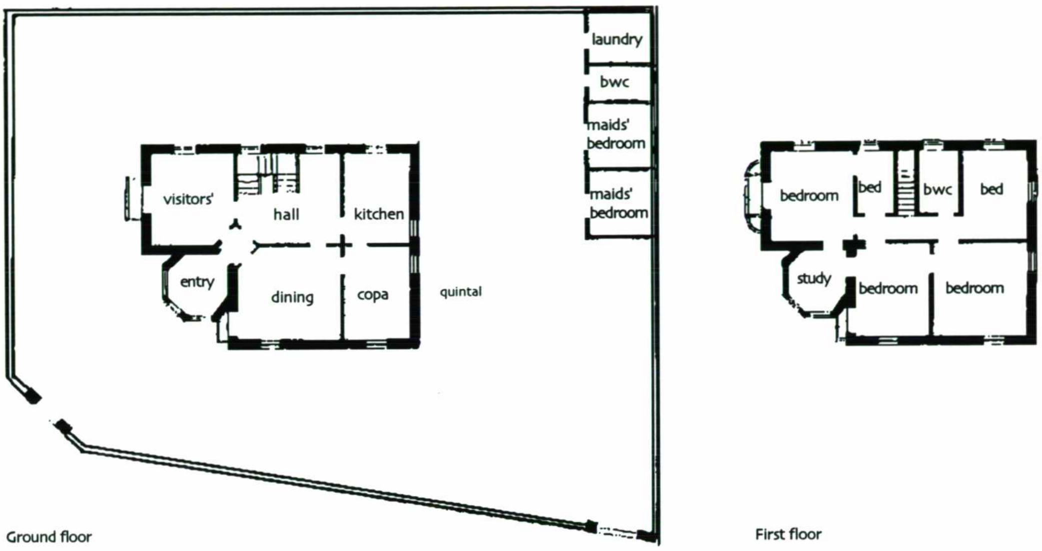

Figure 4.12. Upper-middle class eclectic house

4.4. On the formation of Brazilian society

Travellers' descriptions and architectural studies suggest that the pre-modern dwelling was the symbol of family's privacy. Its organisation proclaimed the segregation of the family from street life and the introduction of visitors under restricted circumstances. The form of Brazilian houses, and the social conduct inside them, seemed old fashioned and unreasonable to a European of "good taste". Darwin, in his walks around Recife and Olinda, was insensible of local codes of behaviour:

One day I took a canoe & proceeded up one of the channels to visit it (Olinda); *I found the old town from its situation both sweeter & cleaner that of Pernambuco. I must commemorate, as being the first time during the four & a half years we have been wandering about; that I met with a want of politeness amongst any class of people; I was refused in a sullen manner at two different houses & obtained from a third with difficulty permission to pass through their gardens to an uncultivated hill for the purpose of taking a view of the country. I feel quite glad this happened in the land of the "Brava Gente", for I bear them no good will* (Darwin, 1933: pp 417 - 418).

Darwin did not realise that the house was the most private domain of the family, and visitors, mostly foreigners, were only received in special occasions. Freyre commented Darwin's reaction with irony: 'But it is possible that the English naturalist, ugly as he was, had frightened women and children, scared with his long beard and hair, when at the province there was a fear for the Cabeleira'[31] (Freyre, 1968: 6). Freyre tries to show that by most visitors certain codes of conduct were not understood. This may have unfavourably influenced the visitors' observations and descriptions.

However, outsiders are able to see things that indigenous cannot clearly perceive, by being used to them. Freyre himself used many of traveller's texts in his studies on the formation of Brazilian society. At the same time he also observed other historical documents and collected personal statements of those who testified to the social changes which occurred after the end of the nineteenth century.

4.4.1. Gender, race and class inequalities

Freyre's studies are centred in the domestic environment, because he believed that 'the complex 'house' is the basis of the bio-social complex which constitutes being a Brazilian' (Freyre, 1979: 13). Freyre's work on Brazilian society is compiled in three books. In his first major study, *Casa Grande e Senzala* (Freyre, 1933), he investigates Brazilian rural society of the first centuries of Portuguese colonisation. He develops the thesis that Brazilian society was tied together by strong bonds of kinship and patronage which characterises the patriarchy. Patriarchy is understood as a social system in which gender and age inequalities are hierarchically arranged, from the youngest children, to women and the male head of the family. The patriarch controls the family affairs, from its wealth to safeguarding its moral values. These patriarchal units were found either as 'extended families', formed by a couple (conjugal family), offspring, relatives and servants; or 'multiple family households', 'which include two or more conjugal family units connected by kinship' (Laslett 1972: pp 29-30). The patriarchy mode was also found in small nuclear families and in various ranks of society (Mello, 1997: 413-414).

This study was followed by two other volumes, *Sobrados e Mucambos* (Freyre, 1936) and *Ordem e Progresso* (Freyre, 1959). In these books the author investigates the transformations occurred in the patriarch society with Brazilian independence (1822), the abolition of slavery (1888) and the advent of the Republic (1889). He argues that in cities, the patriarchy is weakened by

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31 *Cabeleira*, a malicious figure of local folklore.

a closer interaction between families, as well as by the influence of foreign modes of behaviour. This 'semi-patriarchal' system, he suggests, later evolved to what he calls particularism or individualistic form of social organisation, in which the citizen emerges out of the dominance of the local patriarch (Freyre, 1963: 232).

His theories on the formation of the Brazilian society have been criticised for being ideologically constructed, without a support of empirical studies, and also because he attempts to generalise his findings, based on North East Brazil, to the whole of Brazilian society in general. Recent studies have claimed that the patriarchal lineage, in the form depicted by Freyre, was impossible to subsist as a single model to be applied to the whole Brazilian society. For this reason other forms of family organisation must have existed, particularly among lower classes where female-headed families existed (Cândido, 1951; Besse, 1996). Nevertheless, in spite of these criticism most of Freyre's accounts about domestic buildings still remain a powerful resource for social studies.

One of Freyre's main arguments to particularise Brazilian colonial society is that it was more gender than race oriented, in a sense that male/female differentiation were more accentuated than white/native Indian/black inequalities. It seems that these inequalities were differentiated only by strength. The evidences of the inhuman treatment of the black slaves suggests that the miscegenation of races was due to the ruling figure of the white male, rather than the inexistence of racial taboos. On the other hand, it is a fact that mulattos and free slaves acquired civil rights unseen in contemporary Western countries, like the United States of America. Indeed, the Reverend James Fletcher, in the revised 1879 edition of *Brazil and the Brazilians portrayed in historical and descriptive sketches*, highlights that under the Imperial Constitution, 'considerations of race or colour could not be either directly or indirectly the basis for civil rights' (Freyre, 1970: 169), a fact that would shock Americans. However, what Reverend Fletcher did not know, and Freyre does not emphasise, is that not every word of the Constitution was followed by local authorities, subordinated to the patronage of the familial structure.

The mulatto population was the origin of the incipient Brazilian middle class, between the white upper class and the slaves. They fought their way through social ladder by conquering academic titles, being a member of the clergy or the militia (Freyre, 1963: 204). These titles were 'patents of sociological "whiteness" (...) often achieved a social prestige even superior to that of an aristocratic title' (Freyre, 1970: pp 173-174).

Gender and race inequalities are also expressed by the acceptance of the relationship between a white male and black or 'coloured' female, and the taboo against a relationship between a white female and a black male (Freyre, 1963: pp 100-101) This was also a sign of moral double standards, which allowed men the pleasures of sexual freedom, but restrained women's desires.

Distinctive Brazilian social morality was also focus of other interpretations. Roy Nash (1927) perceived its origin in the amalgamation of races. According to him, native Indians placed small values upon virginity and marriage celibacy. On the other hand, 'Negroes, drawn from many distant parts of Africa, brought with them the whole gamut of primitive domestic arrangements from full liberty before marriage to the strictest kind of monogamy' (Nash, 1927: 307). And 'the three great Roman Catholic ideals, though, which were sparsely opposed to the African and Indian codes of sex relations, were monogamy, the indissolubility of marriage and a celibate priesthood' (Nash, 1927: 308) were modified by the Portuguese. He suggests that Portuguese accepted or turned a blind eye to adultery; introduced housemaids, usually called 'subintroduced', to help priests but were in fact their mistresses; and largely accepted prostitutes. The generality of his observations, though, do not hide his own moral prejudices, but were right by indicating the amalgamation of races as the origin of such distinctive culture.

Nash also finds some positive sides in Brazilian society:

There seems to me to be fully as much happiness in the Brazilian houses as I have been privileged to enter as in average North American houses; a feeling of family solidarity which includes the most distant relations; a kindness towards the illegitimate child and its mother which is truly Christlike; an atmosphere where children are very, very seldom abused or coerced; a parental reverence which is beautiful, even if sometimes undeserved (Nash, 1927: 313).

The family solidarity seen by Nash, does not hide the submission of women in this patriarchal society. This was expressed by the phenotypical appearance of males and females: 'He, the strong, she, the weak, he the noble, she, the beautiful. But the beauty he prised was a somewhat morbid beauty'' (Freyre, 1963: 57). Freyre affirms that these gender inequalities were weaker in the semi-patriarchal urban life. The city life, the newcomers and the new habits allowed women to have more freedom (Freyre, 1963: 89), particularly when compared to the secluded rural life, where family social relations were circumscribed to the extended families and neighbours (Mello, 1997: 421). Spatially, however, the *sobrado* and the *casa térrea*, as seen in section 4.3.2., were not more than a confirmation of that seclusion.

In this social scenario the Catholic priest was an important figure in comforting the repressed women. He sustained the primacy of the family vows and of the patriarch as the head of the household. However, as important as the counselling and support given by the Church in women's daily survival, was the relaxation of the country life during the summer periods. That seemed to have been an effective means both to loosen the tight rope of social repression and still keep it under control, as a rehearsed mode of social reproduction. On the other hand, the relative freedom provided by the summer holidays, also suggest that the semi-patriarchal society was not as strict as pictured by Freyre. Indeed, as suggested by Cândido (1951) the Brazilian society was more diversified, coexisting with the patriarchy, nuclear families, or as Laslett prefers, conjugal family units, 'consisted of a married couple or a married couple with offspring, or of a widowed person and offspring' (Laslett 1972: 29). Moreover, the patriarchy even coexisted with consensual unions.

However what is agreed amongst authors is the submissive part assumed by women and children in society. In this gender-differentiated society, children leave their childhood early. The adolescent daughter is married and the son assumes adulthood. It is gender that establishes social position and, sooner these positions are formally assumed, the better. The differentiation between genders was built up in childhood. The boy is given the best education and opportunities, whereas the girls, education is limited and her future is predicted to be a perfect mother, and when married, the daughter would be more related to her husband's family, rather than to hers (Mello, 1997: 421).

Henderson was impressed by the strong surveillance over girls, keeping them behind closed doors, compromising their own health, physically and psychologically (Henderson, 1821). Before him, Koster noticed vexed the subservient female position:

(...) they scarcely receive an education, and have not the advantages of obtaining instructions from communication with persons who are unconnected with their own way of life; of imbibing new ideas from general conversation. They are born, bred, and continue surrounded by slaves without receiving any check, with high notions of superiority, without any thought that what they do is wrong. Bring these women forwards, educate them, treat them as

rational, as equal beings, and they will be in no respect inferior to their countrymen; the fault is not with the sex, but in the state of the human being (Koster, 1816: 388).

Kidder and Fletcher are yet more precise:

The Brazilian mother almost invariably gives her infant to a black to be nursed. As soon as the children become too troublesome for the comfort of the senhora, *they are despatched to school; (...) the Brazilian father thinks that he has done his duty when he has sent his daughter for a few years to a fashionable school kept by some foreigner; at thirteen or fourteen he withdraws her, believing that her education is finished. If wealthy, she is already arranged for life, and in a little time the father presents to his daughter some friend of his own, with a smoothing remark,* "Minha filha, *this is your future husband*" (Kidder & Fletcher, 1857: pp 163-164).

The inequalities between boys and girls are also pictured in literature. In *A Emparedada da Rua Nova*, cited previously, the boy was sent to study in Europe at the age of ten, while the daughter was sent to a local Catholic school. The author strongly opposes this tradition, pointing out that 'to the future mother, to the basis of modern society, moral and intellectual horizons were straitened' (Vilela, 1984: 43). The female world is also portrayed in another romance, *A Renegada* (The Renegade), written in the early twentieth century:

We enjoyed, me and you, dearest Eulália, that bourgeoisie life, satiated and vegetative, of incomprehensible comforts and stupid retreat, that our mother imposed us as the ideal conduct for two wealthy and gifted girls, to whom, when the desired marriage comes, no doctors would refuse it (Fernandes, 1908: 13).

However coherent the descriptions of the foreign travellers may be, and however logical Freyre's argument of a strong patriarchal system tied by social bonds of kinship and patronage may be, it is known that Brazilian society was not exclusively patriarchal. Nevertheless, both descriptive and sociological texts describe gender, race and class inequalities, as pervasive notions in Brazilian society. If the patriarch was not thoroughly found, the male dominance and the colour/class inequalities were deeply embedded in colonial Brazilian society (Cândido, 1951; Besse, 1996).

4.4.2. Reshaping the Brazilian family

In 1889 a civil government assumed rule. The first years of the Republic maintained the principles that ruled the monarchic authority, that of an accomodation of central power to the local patriarchy. However, the decay of the patriarchal agricultural mode of production, moved political power towards a nascent urban bourgeoisie. The urban life became more attractive, offering new opportunities and lifestyle. The previous dirty and unhealthy streets were slowly substituted by a new hygienic city. New suburbs were built and substantial urban reforms were introduced to the major Brazilian capitals. The old tortuous and grim colonial urban fabric was substituted by large avenues and public parks, framed by stuccoed eclectic buildings. The Avenida Central project, in Rio de Janeiro (Fabris, 1987; Needle, 1993), and the reform of the Recife's old quarters (Lubambo, 1991) are examples of this hygienic reformism of Brazilian town centres.

A new lifestyle was in place and women were the most affected by it. This bourgeois urban life, mostly advertised by the cinema (movie theatres spread out in Recife), accounted for a more open and dynamic society, in which social encounters were less controlled or predicted. Women were now invited to take part in a broader social life, leaving the reclusiveness of the patriarchal house. Going shopping and having tea in a tearoom decorated in *French* style, partying in dance halls, and walking in public parks and avenues, were some of the leisure activities offered to the ladies. Despite these advances, a woman of good family would never socialise publicly if unaccompanied.

Besse (1996), in her work on Brazilian society of the first half of this century, takes the problem of gender inequalities to trace how patriarchy was slowly changed to the modern nuclear family, with the cooperation of State intervention. The author describes the national debate on the new role of women in society. Some pictured women's new role as a natural extension of their previous duties as wives, mothers and housekeepers. On the other hand, educators and doctors defended a modern standard for female education and health, in opposition to the ignorant and fragile nineteenth century model. Feminists fought for equal rights, gaining the right to vote (1932) and the regulation of female work, however discriminatory. These feminist conquests were criticised by those who saw in the changing role of the women a threat to the stability of the family and therefore of the whole society. Some of the liberated 'modern' women were pictured as liberal and degenerate (Besse, 1996: 1).

Discussions about the new form of the family became a political and economical project, lead by the government of president Vargas. Inspired by European social reformism, Vargas conceived a national project to lift Brazil towards a modern State. And the family was one of his focuses. The project included providing education and professional formation for male and females, however with explicit differences in terms of curriculum and professional expectancies. Medical facilities and social services were also offered to promote the legitimacy of the nuclear family as the basis of a modern society. Therefore, the wealth and progress of the State would depend on the moral and legal status of the family. With this concept in mind, the government expected to promote economic development in a stable and controlled society. The project aimed at combating the pervasive modern diseases of individualism and egoism, which supposedly threatened the family. Some suggest that the Vargas's populist project (the State propaganda called him 'the father of the nation'), was a form of substituting or appropriating the paternalist figure of the patriarch. In this condition, the State would personify the role previously assumed by the patriarch in regulating the life of women and children in the household .

By the first quarter of the century Brazilian society was formed of an upper class, composed of the descendants of the oligarchy, new industrialists and businessmen; an urban middle class, composed of liberal professionals, managers, office workers, civil servants, small businessman; and a lower class, formed by urban unskilled and skilled workers and poor rural labourers (Besse, 1996: 206). It was this lower class which was essential for the emancipation of the housewife. The freedom achieved by middle-class women, either in developing their professional career or by assuming a more intense social life, was made possible by the support offered by the servants. They assumed the general service of the house and lived within the household (Madeira and Singer, 1973). There were no limits for working hours and, in many cases, it was a career for life. In this sense, female servants 'remained trapped in the domestic sphere under the tutelage of their wealthier female employers' (Besse, 1996: 8). Besse's remarks echo Lemos's observations on the position of the servants in the household.

Besse suggests that the reshaping of the Brazilian family was basically 'to place women in an economically active position, but male dominance was not defeated ,as the moral values of the family still pervaded' (Besse, 1996: 202), and by 'assigning to the updated conjugal family (with women in a central - but still subordinate - position) a heightening role in defending social order and protecting public morality' (Besse, 1996: 200). She also argues that the centralised state, in its project of creating a productive and stable nation, explored the existing gender inequalities and 'institutionalised the power of men over women in laws and social policies that brought gender inequalities more in line with bourgeois notions of individual rights and modern scientific creeds' (Besse, 1996: pp 199-200).

The inequalities between male and female family members, however, did not create the demise of the sensitive issue of individual rights in society, previously weakened under the patronage of the patriarch. To women and children, more choices were offered and their roles in the family were reshaped in order to attend their individual demands. The presence of the male figure was still pervasive and dominant, but the need to educate and shape the character of the individual members of the family to face the requirements of a productive urban lifestyle, relaxed the strict patriarchy family bonds. The huge social and regional inequalities in Brazil, do not allow for a generalisation concerning these changes. However, it seems that in one way or another, the partial changes which occurred in the cities were later, in diverse degrees and forms, spread out to other regions.

4.4.3. A final account

The process of consolidation and transformation of Brazilian society from the initial stages of colonisation to the eve of modernity may be summarised by Freyre's words:

The sociological study of Brazil reveals a process of integration, flowering, and decay of the patriarchal or tutelary form of family organization, economy, and culture. This integration, flowering, and decay - (...) - never took place independently of another equally typical process: the amalgamation of races and cultures which acted as the principal solvent of all that was rigid in the more or less feudal system of relations between men in situations created less by race than by class, group, or individual.

Among Brazilians, the two processes permeated one another, rarely did they collide or come into violent conflict, even though such conflicts did occur. From the beginning of the colonization, the tendency was in the direction of the interpenetration of these two processes.(...)

This brought about what may be considered, from the sociological point of view the beginning of the decline of the patriarchal system, first the rural, which was the most rigid and probably the most typical; then the semi-rural, semi-urban. And along with this decline there took place - or is taking place - the development of forms which some call particularism, or individualism, of family, economic, social organization. There began to emerge more clearly the subjects and then the citizens, formerly almost non-existent among us, so great was the loyalty of the individual to his natural or social father, who was the patriarch, the guardian, the godfather of all,(...) (Freyre, 1963: 232).

If this is the case, the modern houses studied in chapters 2 and 3 were the offspring of this renewed Brazilian society, based on nuclear families. On the other hand, the oppressiveness of colonial domestic space, stage for an absolute need to control and hide family members, was the spatial model of the rural patriarchal and urban semi-patriarchal systems. The degree of privacy generated by these buildings was adjusted to protect the family as whole, as individuals were yet to be given proper rights and independence. In this sense, privacy in pre-modern family, was a different concept from that of the modern family. Privacy was then related to the household members, in contrast to the unhealthy, indecent and uneducated public environment, represented by the streets.

4.5. Zoning the pre-modern dwellings

The possible description of both colonial and eclectic houses of Recife would be a secluded territory for the family, occasionally open to strangers, and maintained by the slaves and servants. If the colonial houses would express the ritualised segregation of the family, the eclectic dwellings would represent the transition from the patriarchy to the modern family. The differences between the two types of dwellings might be the degree of the segregation of the family.

If privacy was somehow treasured as a virtue of the family as a group, more than of their individual members, then it is possible to begin to understand the spatial distribution of activities and household members into diverse territories of the pre-modern urban dwellings. The relationship between inhabitants, visitors and slaves/servants, was essential in structuring the domestic environment, manifesting a strong social regime. The places of each category are expressed in space-time choreography. Vauthier's description of his visit to a *sobrado* (section 4.3.2.1.1.), is a beautiful picture of the strict and yet precise way those categories are choreographically distributed in space and time. The escorted passage from house threshold to the receiving room, where the male ruler is found, and the processional sequence to the dinner room, if invited, reveals the status of each member of the household. Their acts and the scenery convey social status and its own reproduction.

The *casas de sítio,* on the other hand, as temporary housing, or more appropriately, as summer retreats, showed the other face of the patriarchy. This was more liberal, perhaps as a ritualised relief to cope with the pressures of the predominant social rules. Nevertheless, the layout of the *casas de sítio* followed a similar pattern of the urban houses, showing the persistency of the spatial code. It perhaps re-enforced the underlying social rules, only relaxed with the permission of the patriarch. This is because, behind close doors, the social-spatial materialisation is exactly the same as its urban counterpart.

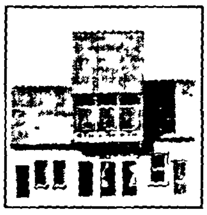
In summary, it seems that the pre-modern dwellings were accommodated to reassure the unity of the family domain by setting spaces for interaction (the back room) and isolation (the alcoves), into a precise realm. This realm was set apart from the spaces solemnly dedicated to the formal entertainment of guests and the ones for the preparation of food, storage of goods, general services and accomodation of horses and slaves, and later servants. These realms constitute the three main sectors of the pre-modern house: the family, the visitors and the service sectors.

The spaces where social or formal encounters are realised can be found in the visitors' sector. It is composed indoors by vestibules, halls, entry or sometimes waiting rooms, visitors' room, reception room, library, music room, and formal dining (contrasting with the *copa* as the daily dining space); and outdoors by front gardens, pergolas and terraces. In opposition to the visitor's sector, stands the service sector, composed by spaces priory occupied by slaves and/or servants, like kitchen, laundry, garage, backyard and servants quarters. Finally, the family sector is composed by daily living spaces - dining room, veranda, family room, bathroom; but also by bedrooms, and peripheral spaces, as boudoir, closet, and toilet.

The testimony given by Vauthier about the similarity between the colonial *sobrado* and *casa térrea* is by itself an indication of a strong spatial pattern, regardless of social class. However, one has to remember that his observations were made in the 1840's, before the abolition of slavery, the introduction of new modes and codes of conduct, and the birth of an urban culture, less enclosed and traditionalist. It is also possible that the late eclectic dwellings, as representatives of a transitional period from a 'semi-patriarchy and familial society', to a 'modern and individualist one', were submitted to a different 'territorial' arrangement. Perhaps the eclectic dwellings managed the conflicts between the development of new gender-relationships and the subsistence of strong family bonds which have always characterised Brazilian society, in a different configuration.

This study, thus, hypothesises the existence of domestic territories in pre-modern houses of Recife. The next chapter aims at identifying, representing and analysing in what way these domestic territories were manifested, if they indeed are to be consistently found in the historical houses.

Chapter Five
From Sociograms to Buildings: the pre-modern houses



The household is a 'sociogram' not of a family but of something much more: of a social system (Hillier & Hanson, 1984: 159).

In the previous chapter the reader was acquainted with the spatial form of the historical houses of Recife and the social structure in which they were embedded. Social studies portray Recife's society in the nineteenth century as patriarchy, male oriented, highly secretive towards women and children, and racially discriminative. This is seen by a strong isolation of the family from the street life, mostly occupied by males, slaves and low-class workers. The domestic ambience portrayed this social system by isolating family life from the street, keeping its female members in their secretive world, and maintaining visitors as peripherally in the house as possible.

Based on historical descriptions and sociological studies, the previous chapter proposed that the colonial and eclectic dwellings were spatially composed in order to reproduce class, gender and race inequalities in the household. It also suggested that the spaces for the use of the family were delimited to a homogeneous sector, regardless of the individual privacy of each member of the family, as a form of expressing the overall hierarchical power structure of the patriarchy. Also, that the slaves, and later servants, were also agglomerated in spaces for their use, segregated from the family realm, and that a very shallow sequence of spaces was opened for social entertainment, forming the visitor's zone.

The aim of this chapter is to investigate how the proposed pre-modern sectors are manifested in the space-function organisation of Recife's historical dwellings. Its first section discusses the availability of colonial and eclectic original plans. Sections 5.2. and 5.3. describes the sectors' analysis of the samples, following the same procedures used in chapter three. Section 5.4. summarises the main findings of each sample which are compared in more detail in the following chapter.

5.1. On the archaeology of dwellings' use

As expressed in chapter 1, the most difficult task in analysing the pre-modern houses is to understand how spaces were used given the information available in houses' plans. The labels do not always represent with accuracy the use it performed. Moreover, some plans are economical in labelling all dwelling rooms.

Great care was taken to deal with the labelling problem. No activity was deliberately attached to any room, unless physical traces or textual references, as described in chapter four, were found. For that reason, the first houses to be investigated were exactly the ones for which textual references were consistent. These references guided the understanding of how inhabitants lived their lives and shed light weather some sort of sectoring was embedded in their spatial-functional system.

Another important reference for the development of the sectors' analysis of the pre-modern houses was the investigation carried out by Trigueiro (1994) on the spatial morphology of historical houses of Recife. Her study revealed that albeit the remarkable similarities of houses' plans, fundamental differences are present in their configurations. Trigueiro suggests that there are three distinct spatial patterns within colonial housing. One type of dwelling is male-visitors-centred, integrated by the front-formal-receiving room. In this type the dining room is relatively integrated, but the kitchen is highly segregated. This pattern is rigidly structured and stable, regardless of the introduction of external connections to the configuration. It is predominantly found among urban *sobrados*. Another group is family-centred, integrated by the back-informal-dining room. The kitchen remains as the most segregated amongst the main domestic functional rooms. This pattern is also strong and is mostly associated with *casas de sítio*. Trigueiro also identifies a third significant trend amidst the colonial *casas térreas*, which is dining-centred. In this type, however, the kitchen is more integrated than the visitors' room. This pattern is less stable then the previous ones, particularly when the exterior is included in the system pulling the visitors' room to the highest levels of integration.

The stability of the colonial model is substituted by a more unstable eclectic system, in which the introduction of outside connections have deep effects in the configuration of the dwellings. Dining-centred houses are predominant in this group, which is also characterised by segregated kitchens. However, the receiving and cooking spaces may vary their position in the rank order of integration. This instability in perceived in different housing types and social classes as well.

It is interesting to observe if these patterns are somehow revealed in the sectors' structures of the houses. Perhaps, the basis for such patterns lies on the arrangement of the functional sub-complexes in their layouts. The analysis that follows is also concerned with the fact that the sectors' structure of the houses may be influential in the generation of space-to-space regularities. This problem is observed in more detail in chapters six and seven.

But the problem for developing a consistent analysis of the sectors' configuration of these historical houses remains in observing where similar kinds of domestic activities are developed. At this stage, it is important to remind the reader that a house is not a simple functional artefact that induces an indefinite repetition of certain kinds of operations in certain kinds of conditions, pre-determined by a social logic embedded in their layouts. It would be naive to believe that individual will is absolutely subordinated to the way space and functions are organised in buildings. Indeed, activities may be taken in spaces in which they were not supposed to be taken and developed by household members who were not supposed to do so. Formal etiquette may be relaxed and strangers and inhabitants may feel free to behave in a less formal way and occupy spaces which otherwise would be reserved for inhabitants' intimacy. Historical literature insinuates how the spatio-functional logic of the colonial dwellings were systematically subverted by the intrusion of unwanted Don Juans in the well-protected madam's' alcove, through the same ringy structure which permitted the patriarch to move about without being noticed.

This unpredictability of house use (or it should be said, of buildings is general) may be seen as a strong argument against the analytical perspective used in this research. Fixing a predetermined functional structure and taking it as the meaningful core of houses' existence is quite a radical approach passive of being interpreted as simplistic in its essence. However, the form function is assigned to space and how classes of spaces are ordered and grouped together has a meaning in itself. It is through this simple process that buildings acquire and carry social meaning. According to Markus (1987), 'there is no building type in which a division of people, objects, and machines, and their spaces, into classes and categories, as the first step towards their organised and purposeful interface, is not of primary importance' (Markus, 1987: 468). It was as 'classifying devices', as referred by the same author, that the pre-modern dwellings of Recife materialised the very nature of a strict patriarchal society, classifying classes of users and their occupational areas.

The understanding of buildings as spatio-functional complexes conceived to stage specific plays under particular circumstances is the foundation of this research and it is through this spectacle that the historical houses of Recife are observed. The archaeology of houses' use tried to identify the classes that the device generated in order to establish itself as media for social production and reproduction. And this seems to occur when social formality begins and actors and roles are defined, and when the spatial structure has to respond efficiently to these occasions. This is exactly why the building has to act as a device to allow this social operation to take place. The analysis developed in this chapter tries to portray the houses in these very circumstances.

5.2. The colonial house

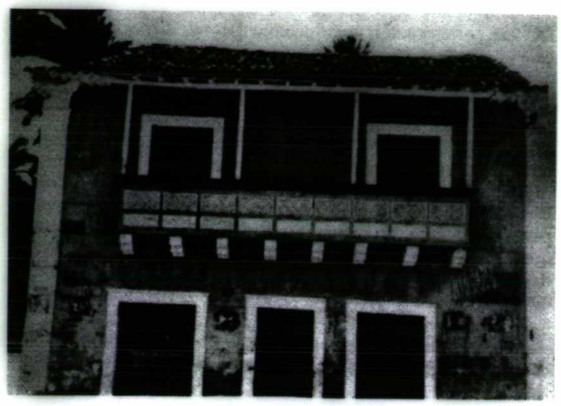
5.2.1. The sample and its sectors' representation

The collected sample is composed of fourteen colonial dwellings: nine *casas térreas*, one *casa térrea* with attic and four *sobrados*. Twelve dwellings are terraced, and the remaining two are semi-detached and detached. The complete plans of the houses are presented in the attached laser disk, but figure 5.1. shows some of the colonial exemplars.

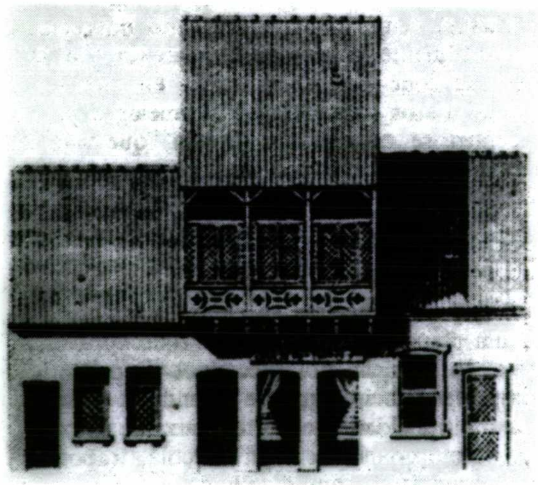
The *sobrados*' exemplars are formed by Vauthier's typical plans of the houses of 'respectful' and 'wealthy' citizens (Vauthier, 1975), and by two sobrados of the neighbour city of Olinda, studied by Pinto (1975) and Smith (1975). These were the only complete and reliable plans of sobrados to be collected. They were occupied by the higher ranks of society, from high-middle to upper class.

The *casas térreas*, according to Vauthier (1975), were occupied by the lowest ranks of the society. He describes the houses as having a front room, followed by a sequence of alcoves and, at the back, a room that would serve as a dining room and kitchen, unless an extension is built for this use. The front room and some alcoves would have a ceiling, but in most of the cases the roof is left bare, allowing air to flow and refresh the house (Vauthier, 1975: pp 63-64). Houses C1 to C9 confirms Vauthier's description. They present the typical layout described by Vauthier extended with some ancillary rooms, perhaps late additions to the original plan. These extensions house bathrooms, storage rooms and slaves accommodations and are accessible through the *quintal*, the focus of the service activities. The *casa térrea* with attic (C10)

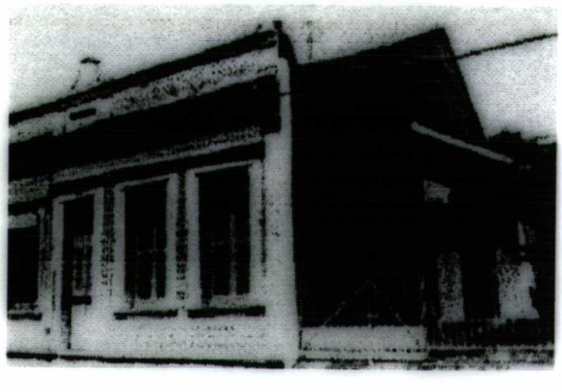
Sobrado



House C13



Casa térrea and sobrado,
after Vauthier, 1975



House C8

Figure 5.1. Colonial dwellings

follows the same pattern, notwithstanding the existence of family rooms in the attic.

Figure 5.2. shows the plan of House C3. The front-formal visitors' room is directly accessed from the street, but it is likely that it was protected from pedestrians' gaze by a fine lattice work, known as *gelosia*. This room is connected to the front alcove, usually occupied by the head of the family and his wife, and to the spine-like corridor, which gives access to the dining room, the centre of the family life. The kitchen, bathroom and service rooms are situated in an extension, all accessible from the backyard. This simple layout compose a simple sectors' diagram, composed of a shallow visitors' sector, a family sector at the centre, and a deep service sector. The ancillary rooms at the rear end, if not original, do not interfere with this sectoring pattern because their uses were exclusively for service purposes. With or without them, the house would present the same sectors' graph.

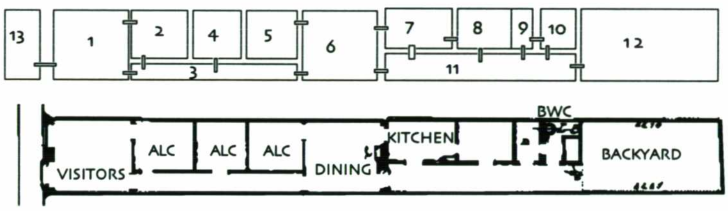


Figure 5.2. House C3: plan and convex break up

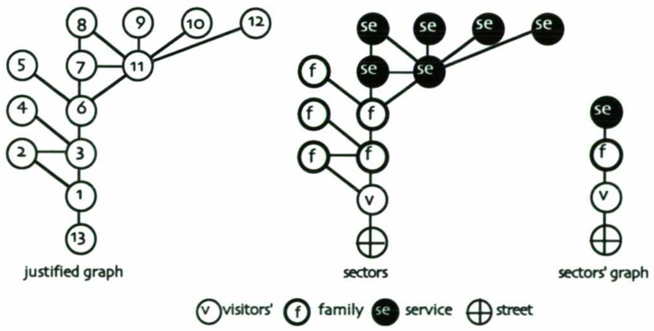


Figure 5.3. House C3: justified graphs

The *sobrados* (houses C10 to C14) are, however, more complex, as seen in the plan of house of Vauthier's 'respectful man' dwelling (C12), in figure 5.4. A visitor accesses the house through a large vestibule and reaches the first floor receiving rooms through a central staircase. As in the typical *casa térrea*, the front room is for receptions and the back room for family use. The alcoves, disconnected from the main corridor, are linked through a secretive passage, which also permits an alternative line of movement within the layout.

Other features distinguish this house, and the *sobrados* in general from the *casas térreas*. For example, the slaves accommodations and other service related spaces are isolated in two extreme parts of the *sobrado*, the attic and the ground floor. The female slaves accommodation and the kitchen are situated in the attic, for keeping the female slaves at hand for any house work and providing a more efficient exhaustion of the fume. The male slaves accommodations and other service related spaces are situated in the ground floor, maintaining a safe separation between male slaves and the family precincts. Alcoves are also more dispersed in the household and guests rooms are introduced. However, both types seem to reproduce the same model, which keeps visitors peripheral and maintains the integrity of family life by segregating it and controlling the access to its compartments. This can be seen in the sectors' graph of the respectful man's house, shown in figure 5.5.

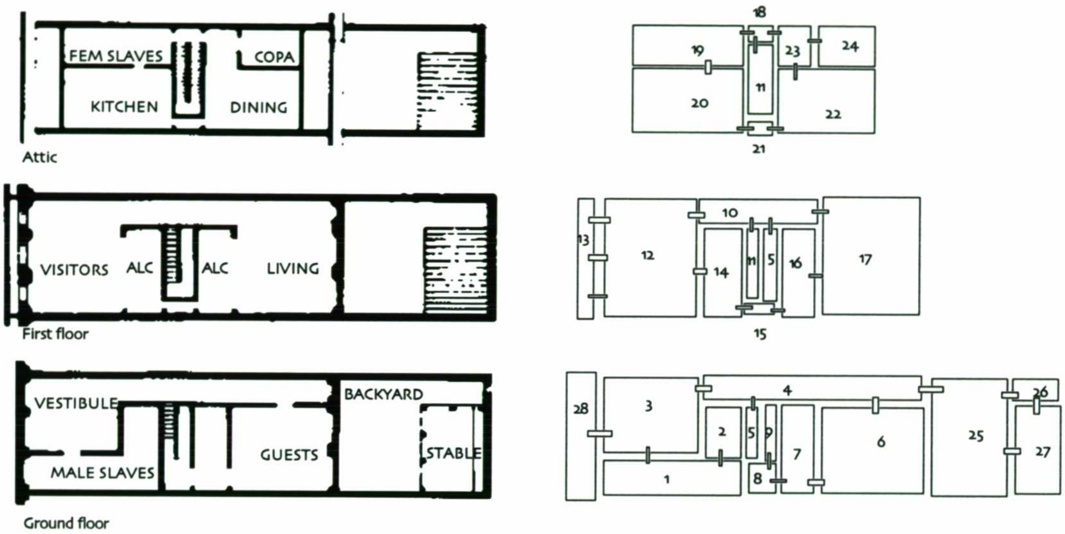


Figure 5.4. House C12: plan and convex break up

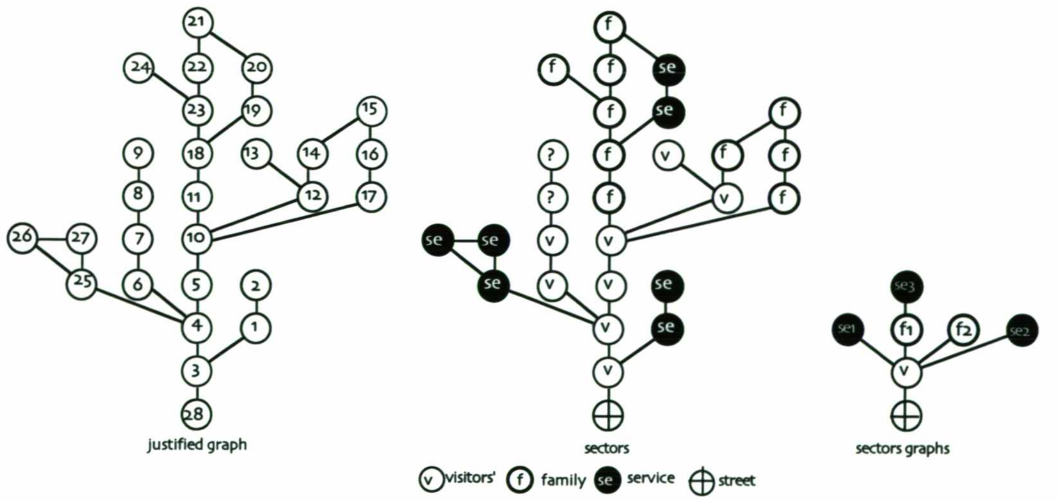


Figure 5.5. House C12: justified graphs

5.2.2. General properties

The same analytical procedures used in the previous chapter are used to investigate the pre-modern houses. The results and the general characteristics of the house are resumed by table 5.1. As the dates of construction of the

Table 5.1. Colonial houses: general and syntactic data

Houses		Location			House			Area		Width	Convex spaces					Graph			visitors'		family		family 1		service		service 1		service 2		store		exterior	
code	Address/identification	district	locality	class*	types	st	fl	plot	house	plot	all	t	ed	out	in**	T	S	MRRA	st d	RRA	st d	RRA	st d	RRA	st d	RRA	st d	RRA	st d	RRA	st d	RRA	st d	RRA
C1	Benfica, 1140	fourth	Derby	mc	ter	grd	1	130.0	83.0	4.40	11	7	1	3	8	Ta	4	1.999	b 1	0.999	b 2	0.999			a 3	2.999							a 0	2.999
C2	Riachuelo, 649	first	Boa Vista	mc	ter	grd	1	133.0	92.0	4.10	11	6	3	2	9	Ta	4	1.999	b 1	0.999	b 2	0.999			a 3	2.999							a 0	2.999
C3	Soledade, 65	first	Boa Vista	mc	ter	grd	1	215.0	105.0	4.00	12	8	2	2	10	Ta	4	1.999	b 1	0.999	b 2	0.999			a 3	2.999							a 0	2.999
C4	Benfica, 1134	first	Derby	mc	ter	grd	1	180.0	69.0	6.40	13	8	2	3	10	Td	5	1.515	b 1	0.947	b 2	0.474			a 3	1.839	a 3	1.839					a 0	2.367
C5	Cupim, 47	first	Aflitos	mc	ter	grd	1	113.0	86.0	4.20	14	10	2	2	12	Ta	4	1.999	b 1	0.999	b 2	0.999			a 3	2.999							a 0	2.999
C6	Joaquim Nabuco, 305	first	Graças	mc	ter	grd	1	200.0	125.0	5.40	15	7	4	4	11	Td	5	1.515	b 1	0.947	b 2	0.474			a 3	1.839	a 3	1.839					a 0	2.367
C7	Joaquim Nabuco, 690	first	Graças	mc	s-det	grd	1	370.0	207.0	11.20	20	6	7	7	13	Tb	4	0.999	c 1	0.000	c 2	0.999			c 2	0.999							a 0	1.999
C8	Br. de São Borja, 69	first	Boa Vista	mc	ter	grd	1	320.0	211.0	6.00	23	15	6	2	21	Ta	4	1.999	b 1	0.999	b 2	0.999			a 3	2.999							a 0	2.999
C9	Amélia, 327	first	Graças	mc	det	grd	1	515.0	158.0	12.60	26	9	9	8	18	Tc	4	0.999	c 1	0.999	c 2	0.999			c 1	0.999							c 0	0.999
C10	Paissandu, 309	first	Paissandu	hmc	ter	attic	2	219.0	390.0	7.60	33	25	3	4	28	Tc	4	0.999	c 1	0.999	c 2	0.999			c 1	0.999							c 0	0.999
C11	Amparo	olinda	Olinda	hmc	ter	bas	2	115.0	95.0	4.40	19	14	1	4	15	Tf	6	0.955	d 1	0.573	c 2	0.573			a 3	1.719	c 1	0.860			c 1	1.146	d 0	0.860
C12	Respectful man'	first	Recife	hmc	ter	M	3	81.0	160.0	5.50	27	24	0	3	24	Th	7	1.066	b 1	0.196	a 2	1.177	b	0.785	a 3	1.766	a 2	1.177	a 2	1.177			a 0	1.177
C13	Pça de São Pedro	olinda	Olinda	uc	ter	M	2	220.0	332.0	11.50	33	22	2	9	24	Tg	6	0.860	d 1	0.573	c 2	0.573			a 3	1.719	d 1	0.573			d 1	0 860	d 0	0.860
C14	Wealthy man'	first	Recife	uc	ter	M	4	200.0	840.0	7.70	55	42	0	3	52	Te	5	1.515	b 1	0.474	b 2	0.947			a 3	2.365	a 2	1.894					a 0	1.839
Mean all								215.07	210.93	6.79	22.29	14.50	3.00	4.00	18.21																			
	ground (*casas térreas*) - C1 to C9							241.78	126.22	6.48	16.11	8.44	4.00	3.67	12.44																			
	levels (*sobrados*) - C10 to C14							167.00	363.40	7.34	33.40	25.40	1.20	4.60	28.60																			

* After Trigueiro, 1994

** Indoors convex spaces include the house and the edícula

mc=middle-class; hmc=high-middle class; uc=upper-class; ter=terraced; s-det=semi-detached; grd=ground; bas=basement; M=levels

st=space type; d=depth

houses were not available, the sample is ordered first by number of floors and then by the number of convex spaces, from the smallest to the largest complex.

The houses collected in the sample are situated in the centre of the Recife, its suburbs and in the neighbour city of Olinda. Vauthier's 'respectful' and 'wealthy man' houses represent the typical *sobrados* of the old town of Recife and houses C11 and C13 represent some of the typical features of the urban houses of Olinda. Houses C2, C3 and C8, were built in Boa Vista, the first expansion of the city fabric inland, and the remaining houses were built in the suburbs of Derby and Graças, some of the many summer retreats described in the previous chapter.

The situation of the houses in the city structure reflects in the typology they assume. The majority of the houses (85.71%) is terraced, representing the traditional urban dwelling form. The only detached (C9) and semi-detached (C7) houses found in the sample are situated in Graças, where land was available and therefore the building could be recessed from the limits of the property. It is possible that house C9 was in fact a *casa de sítio,* occupied seasonally, but later embraced by the expansion of the urban fabric.

The sample varies in terms of the height of the dwellings. Ground-floor houses form the absolute majority of the sample, with nine exemplars (64.28%). Three houses (21.43%) have two storeys, but one in form of an attic and another as a basement. Vauthier's typical sobrados are the highest dwellings with three and four storeys.

The sample is also diverse in terms of area. The colonial houses area range from 83.00m^2 to 840.00m^2, with an average of 210.93m^2. The *sobrados* are the largest units, with an average of 363.40m^2, whereas the *casas térreas* have on average 126.22m^2. Verticality is an indicator of house area, but plot size does not necessarily indicate the size of the house. This is because the *sobrados* are squeezed into small urban plots, whereas some of the *casas térreas* were built in the outskirts of the city where land was available. Plot area ranges from 130.00m^2 to 515.00m^2, with an average of 215.07m^2. The *sobrados* have an average of plot area of 167.00m^2, whereas the *casas térreas* have an average of 241.78m^2. This indicates that *sobrados* are more likely to be found in the town centre, with reduced availability of land, therefore verticality is required.

One characteristic of the colonial houses is the coincidence between their layout and convex map. The number of indoor convex spaces range from 8 to

52, with an average number of 18.21 convex spaces for the sample. The whole complex, which combines indoor and outdoor spaces, ranges from 11 to 55 convex units, with an average for the sample of 22.

As in the modern dwellings, topological and geometrical sizes present a significant correlation. House area and indoor convex spaces (which also counts the edícula) have a strong and significant correlation of 0.908r2, p=0.0026 (figure 5.6.). Similar values are found for the correlation between house area and the total number of convex spaces (0.892r^2, p=0.003). These results indicate that the bigger the house, the higher the degree to which they are broken up into convex spaces. The high correlation value is undoubtedly guided by the size of the 'wealthy man' house (C14), however the correlation values for the sample without including this house is still high (0.681r^2, p=0.0001, for the interior, and 0.698r^2, p=0.0001, for the whole complex).

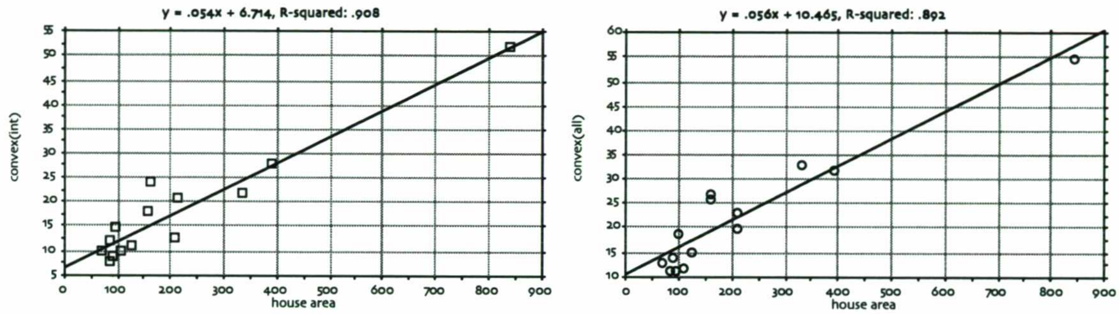


Figure 5.6. Correlation between house area and convexiality a) indoors b) whole complex

On the other hand, plot size does not predict convex articulation (figure 5.7.). The correlation between plot area and indoor convex spaces is 0.004r^2 (p=0.0001) and for the whole complex is 0.032r^2 (p=0.0001). These values for the correlation between plot area and convexiality, i.e., the number of convex spaces, are more representative when the sample is split into *casas térreas* and *sobrados*. [32] For the *casas térreas*, the correlation between plot area and interior convex spaces becomes 0.553r^2 (p=0.0008), whereas with the whole complex becomes 0.851r^2 (p=0.0067) (figure 5.8.). For the *sobrados* it becomes 0.168r^2 (p=0.0067) for interior, and 0.307r^2 (p=0.0068) for the whole complex, still weak, as expected while their verticality overcomes plot limitations (figure 5.9.).

[32] House C10, a *casa térrea* with an attic, is included in the *sobrados*' group

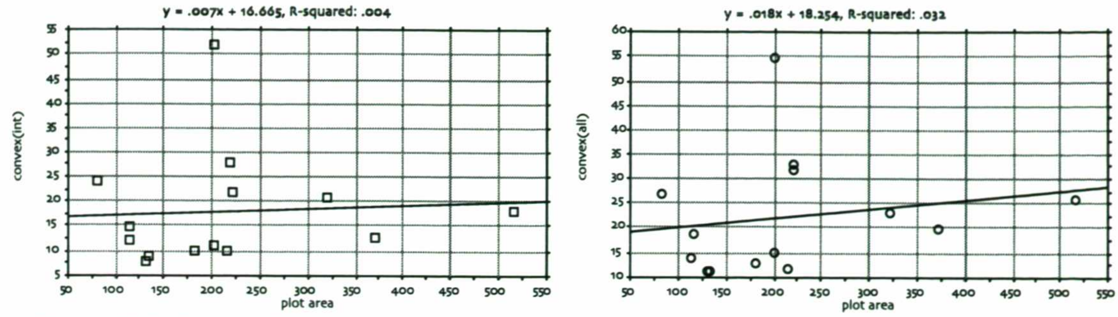


Figure 5.7. Correlation between plot area and convexiality: a) indoors b) whole complex

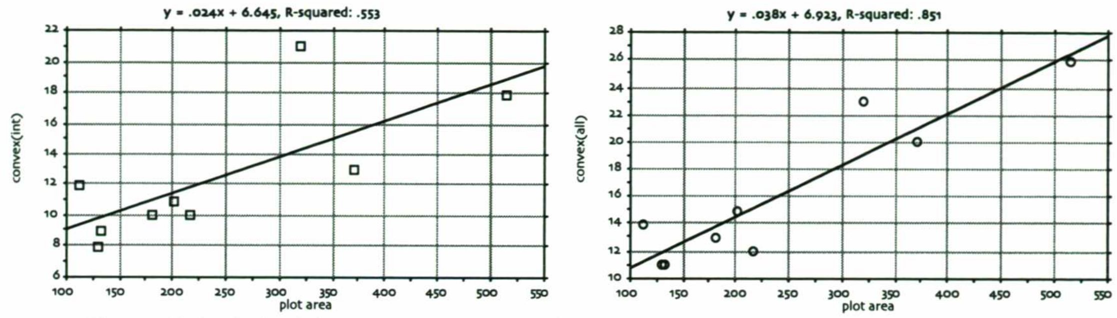


Figure 5.8. Colonial *casas térreas*: correlation between plot area and convexiality: a) indoors b) whole complex

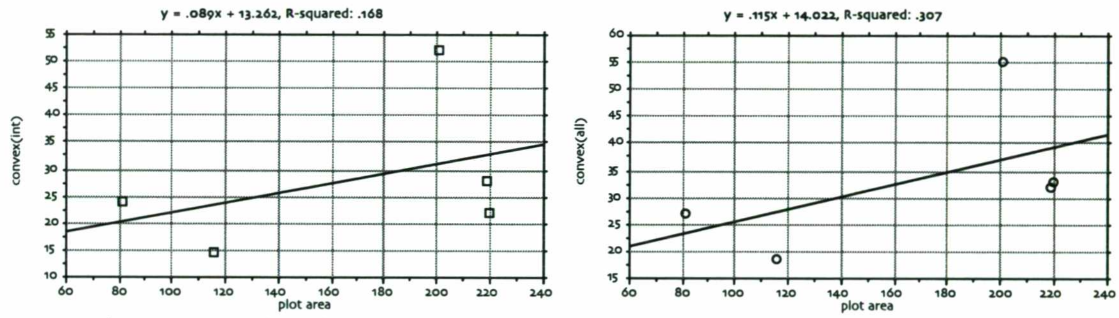


Figure 5.9. Colonial *sobrados*: correlation between plot area and convexiality: a) indoors b) whole complex

If social status is indeed measurable by the width and height of the houses, as Vauthier has suggested (Vauthier, 1975: 64), then the sample confirms this (table 5.1). For example, the more modest houses with a single door and window (*porta-e-janela* houses) have very simple programs. The front room is directly opened to the street (even though always protected by *rótulas* - trellis windows), and the number of rooms is reduced (figure 5.1.). When the plot is wider, the number of windows is increased and a formal vestibule is included, adding one further degree of isolation. If the width is considerable, the house may be semi-detached (House C7), creating a lateral garden, or even fully detached (C9). In these circumstance the program of the house tends to become more complex, with the introduction of new spaces (vestibule, for example) or multiplication of others (alcoves and service rooms). This is more evident when verticality is used as a sign of wealth. The program becomes more and more complex with a multiplication of alcoves (figure 5.3.). The wider the plot, more complex the program, and higher the owner's status.

Correlation values confirms this relationship between width and convexiality (figure 5.10.). For example, in *casas térreas* the correlation is positive and significant for the whole complex (0.653r2, p=0.0001) but is weak for the interior spaces (0.279r2, p=0.0015). However, the correlation between width of the plot and the number of *edícula* spaces is strong (0.779r2, p=0.0007) indicating that within *casas térreas* wealthy is expressed by the number of service rooms and slaves' accommodations.

As would be expected, *sobrados*' convexiality do not present a good correlation with plot width, because verticality overcomes plots' limitations. The values do not indicate any correlation at all, 0.169r2, p=0.0112, for the complex and 0.036r2, p=0.0099, for indoors (figure 5.11.). However, convexiality is well predicted by the number of floors (figure 5.12.). The correlation for the whole sample (*casas térreas* and *sobrados*) is 0.723r2 (p=0.0001) for houses' complex and 0.776r2 (p=0.0001) for indoor spaces. If the *edícula* is excluded and only the spaces of the main building are considered, this correlation becomes even stronger (0.874r2, p=0.0007).

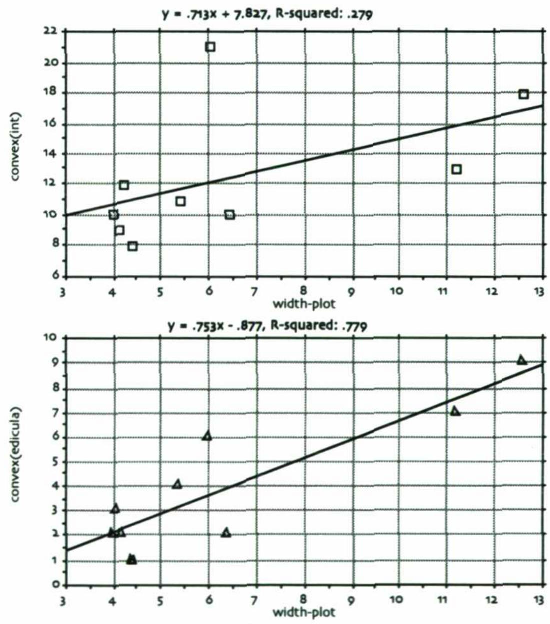


Figure 5.10. Colonial *casa térreas*: correlation between plot width and convexiality: a) indoors, b) whole complex c) *edícula*

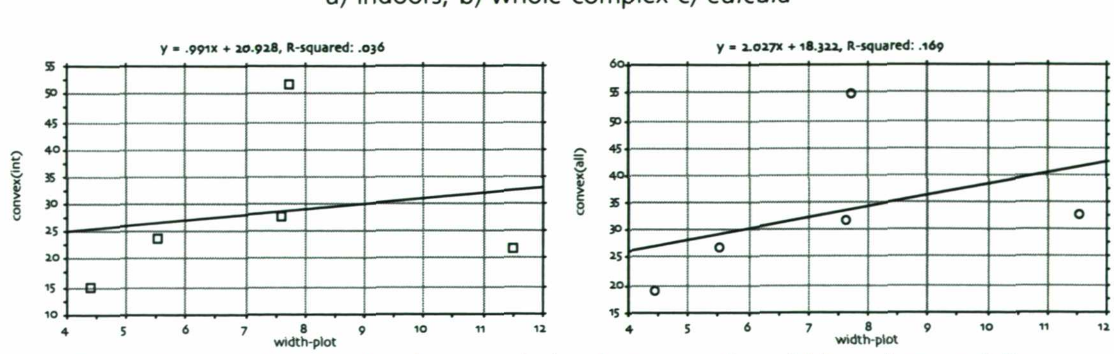


Figure 5.11. Colonial *sobrados*: correlation between plot width and convexiality: a) indoors, b) whole complex

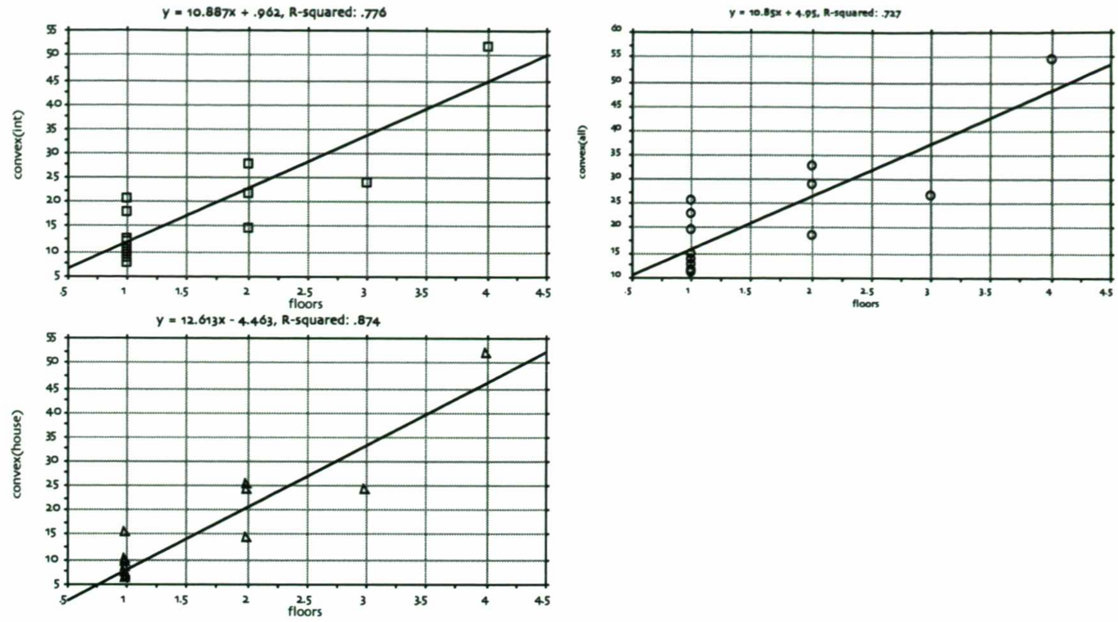


Figure 5.12. Colonial *sobrados*: correlation between plot width and convexiality: a) indoors, b) whole complex c) house without the *edícula*

In sum, the colonial sample demonstrates that geometrical and topological sizes are well correlated, and that plot width is a good predictor of convex articulation in ground-floor houses, whereas verticality is more efficient for capturing *sobrados*' characteristic. Verticality also correlates positively with social class (0.884r^2, p=0.0548) (figure 5.13.). Middle-class houses tend to be found as terraced-ground-floor dwellings, whereas upper-class residences are mostly found as terraced-multi-floor dwellings.

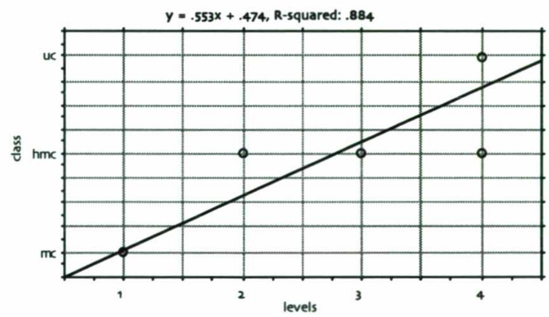


Figure 5.13. Correlation between houses' levels and social class

5.2.3. The sector's analysis

The number of sectors' arrangements found in the colonial houses is quite surprising in face of the number of dwellings examined (figure 5.14. and tables 5.1. and 5.2.). There are eight different arrangements for fourteen cases, with a ratio of 1.75. This may appear as a very speculative set of dwellings, sector wise, however, it seems that the number and form of the sectors' graphs resulted from the composition of the sample itself. In other words, the sectors' arrangements correspond to solution-types.

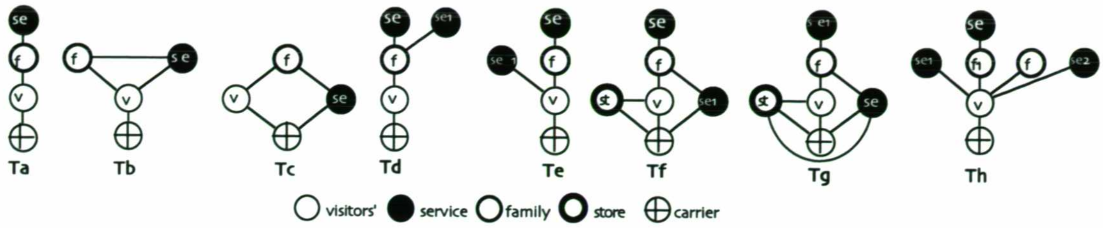


Figure 5.14. The colonial sectors' graphs

Table 5.2. The configurational properties of colonial graphs

Sector	House								visitors'		family		family 1		service		service 1		service 2		store		exterior	
T	s	c	MRRA	a-ness	b-ness	c-ness	d-ness	DV	s d	RRA	s d	RRA	s d	RRA	s d	RRA	s d	RRA	s d	RRA	s d	RRA	s d	RRA
Ta	0	5	1.999	0.67	1.00	0.00	0.00	2.40	b 0	0.999	b 0	0.999			a 0	2.999							a 0	2.999
Tb	0	0	0.999	0.33	0.00	0.75	0.00	2.77	c 0	0.000	c 0	0.999			c 0	0.999							a 0	1.999
Tc	0	0	0.999	0.00	0.00	1.00	0.00	4.00	c 0	0.999	c 0	0.999			c 0	0.999							c 0	0.999
Td	5	0	1.515	0.75	0.67	0.00	0.00	2.12	b 0	0.947	b 0	0.474			a 0	1.839	a 0	1.839					a 0	2.367
Te	5	0	1.515	0.75	0.67	0.00	0.00	2.12	b 0	0.474	b 0	0.947			a 0	2.365	a 0	1.894					a 0	1.839
Tf	6	0	0.955	0.20	0.00	0.50	0.33	1.94	d 0	0.573	c 0	0.573			a 0	1.719	c 0	0.860			c 0	1.146	d 0	0.860
Tg	6	0	0.860	0.20	0.00	0.17	0.67	2.58	d 0	0.573	c 0	0.573			a 0	1.719	d 0	0.573			d 0	0.860	d 0	0.860
Th	7	0	1.066	0.83	0.40	0.00	0.00	2.70	b 0	0.196	a 0	1.177	b	0.785	a 0	1.767	a 0	1.177	a 0	1.177			a 0	1.177

Y=type, s= size; c= cases; st=space type; d= depth from street

The arrangements *Ta* and *Td* are found in terraced middle-class houses. The difference between these two types is the isolation of the kitchen from the rest of the service spaces by means of a family terrace, an extension of the dining or *sala de trás*. This terrace was used for leisure but also for domestic tasks, therefore its direct link to the kitchen. Despite this minute differentiation, the sequence visitors, family and service is not changed. Type *Tb* is found in a semi-detached house, therefore allowing movement from the front-receiving-garden to the backyard, even though it would be impolite to any visitor to invade such territory without inhabitants' allowance. Type *Tc* corresponds to a detached house situated at a corner site with double entrance. If the service entrance were not present, then the graph would assume the type *Ta* form.

Types *Te* to *Th* correspond to *sobrados*. Types *Tf* and *Tg* are surprisingly similar, corresponding to the *sobrados* of Olinda. The difference between the two cases resides on the connection of the store, or *armazém*, in the ground floor to the service area of the houses. In house C11, situated at Amparo Street, the store is isolated from the service area because of the differences of level between the main entrance and the back yard. If the store were isolated from the complexes, both houses would present the same graph (figure 5.15.)

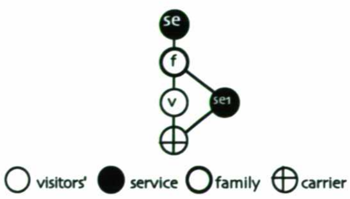


Figure 5.15. Alternative sectors' graph of houses C11 and C13, without the store

Finally, types *Te* and *Th* correspond to Vauthier's *sobrados*. They are also similar in their tree-like form and in sub-division of the service sector. The particularity of type *Th* (C12) is the existence of two family sectors, due to the visitor's access in the main floor (figure 5.3.). The secondary family sector is former by the recessed dining room at the attic, whereas the main family sector comprises the *sala de jantar* and alcoves.

The service sector is also split in some cases. Within the ground floor houses it is split in type *Td*, as referred above, but amongst the *sobrados* it is split in all cases. In Vauthier's types (*Tf* and *Th*), the service sector is split into a ground-floor-male-slaves-area and into a top-floor-female-slaves-area. The second corresponds to the kitchen. This separation between the kitchen and the other service rooms is also seen in Olinda's dwellings. In every case the main service sector is the one in which the kitchen is included, as this space is closely related to the other sectors.

5.2.3.1. Graphs by size

The sectors' graphs range from four to seven nodes, according to the introduction of secondary sectors to the visitors-family-service sectors model. Table 5.3. describes the graphs per size and their occurrences by social class, levels and area. The four element graphs are found in three different arrangements (*Ta* to *Tc*), corresponding to eight houses (57.14%). They are formed by the main sectors and the exterior. These are the most popular amongst the sample. They are mostly found in middle-class-ground-floor-terraced houses, suggesting that the outstanding majority of four element graphs in the sample is a result of sample's composition. In other words, as *casas térreas* form the majority of the sample and their sectors' organisation follow similar patterns, the overall result is determined by these houses. These are also, on average, the smallest houses of the sample both geometrically (average house area is 166.50m^2) and topologically (18.25 convex spaces, indoors and outdoors, and 14.87, indoors). The average plot area is, however, the highest of the sample (251.87m^2), due to the availability of land in the outskirts of the town centre, where some of these houses were built.

Table 5.3. The colonial general data by topological size

Size	Cases		Social class			Levels				Type *			Area (m2)		Convex spaces	
	Total	%	mc	hmc	uc	grd	att	bas	str	t	s-d	d	Plot	House	All	Interior ;
4	8	57.14	7	1	0	7	1	0	0	6	1	1	251.87	166.50	18.25	14.87
5	3	21.42	2	0	1	2	0	0	1	3	0	0	193.33	344.67	27.33	23.33
6	2	14.28	0	1	1	0	0	1	1	2	0	0	167.50	213.50	24.00	19.00
7	1	7.14	0	1	0	0	0	0	1	1	0	0	81.00	160.00	27.00	24.00

* mc=midlle class; hmc=high-middle class; uc=upper class; t=terraced; s-d=semi-detached; d=detached

The five element graph is formed with the detachment of the kitchen from the other service rooms, either isolated in the top-floor of the *sobrado* C14, or disconnected from the other service spaces in the *casas térreas* C4 and C6. This group corresponds to the graphs *Td* and *Te*, which comprises three houses (21,42% of the sample). The type *Td* is formed by ground-floor-middle-class dwellings, whereas type *Te* corresponds to Vauthier's 'wealthy man' residence. Because of this particular case, the average area for this set of graphs is the highest of the sample, with average values of 193.33m^2 and 344.67m^2 for plot and house areas, and 27.33 and 23.33 average convex spaces for the whole complex and the interior, respectively.

The six and seven element graphs are formed with the multiplication of service and family nodes, and the introduction of a store in Olinda's *sobrados* (C11 and C13). Both groups are formed by terraced *sobrados*, occupied by either high-middle or upper classes. The number of convex spaces is higher than the four element graph houses but smaller than the average of the five element graph houses, due to house C14, the largest of the sample (see table 5.3.)

In general terms it may be said that size of the graphs and houses' area and complexity are directly related, so that small graphs correspond to more modest dwellings, whereas more complex graphs would correspond to more complex and sophisticated dwellings.

5.2.3.2. Space-type

Labelling the graphs by space-type and counting their occurrences by sector gives an interesting insight on the relation between house types and the configuration of their sectors (see figure 5.16. and table 5.4). The first aspect to be noted is the variety of forms assumed by the sectors in the graphs. If the modern sectors were found in a consistent pattern, for example social and service sectors always being included in at least one ring, the colonial sectors assume diverse and contrasting positions.

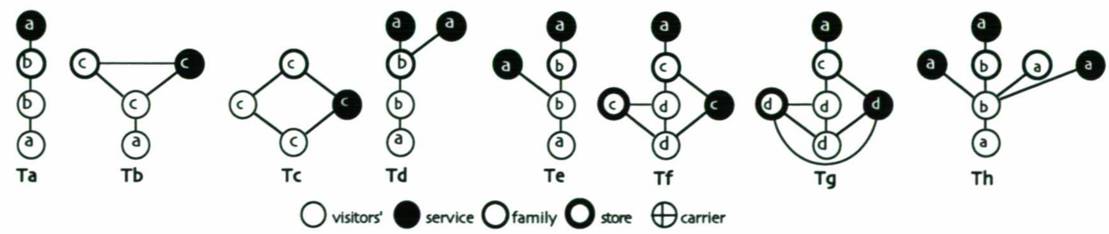


Figure 5.16. The colonial sectors' graphs by space-type

Table 5.4. Space-types: occurrence in the colonial sample

Sectors by space type - numbers per graphs																
type	v	%	st	%	f	%	f1	%	se	%	se1	%	se2	%	e	%
a	0	0.00	0	0.00	1	12.50	0	0.00	6	75.00	3	60.00	1	100.00	5	62.50
b	4	50.00	0	0.00	3	37.50	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00
c	2	25.00	1	50.00	4	50.00	0	0.00	2	25.00	1	20.00	0	0.00	1	12.50
d	2	25.00	1	50.00	0	0.00	0	0.00	0	0.00	1	20.00	0	0.00	2	25.00
Sectors by space type - cases in the sample																
type	v	%	st	%	f	%	f1	%	se	%	se1	%	se2	%	e	%
a	0	0.00	0	0.00	1	7.14	0	0.00	11	78.57	4	28.57	1	7.14	10	71.43
b	9	64.29	0	0.00	8	57.14	1	7.14	0	0.00	0	0.00	0	0.00	0	0.00
c	3	21.43	1	7.14	5	35.71	0	0.00	3	21.43	1	7.14	0	0.00	2	14.29
d	2	14.29	1	7.14	0	0.00	0	0.00	0	0.00	1	7.14	0	0.00	2	14.29

The visitors' sector is found as a b-type space in four graphs (*Ta*, *Td*, *Te* and *Th*), corresponding to 64.29% of the sample. It is also included in rings. As a c-type, the visitors' sector is found in two graphs, *Tb* and *Tc*, corresponding to 21.43% of the cases, and as a d-type space in the remaining two graphs (*Tf* and *Tg*), found in two houses (14.29%). It is interesting to note that the visitors' sector becomes a d-type space with the link to the store premises. If this link is retrieved, in order to exclusively examine the housing spaces, the sector would become a c-type space. This result indicates the nature of the visitors' sector, which is to maximise depth in the system, serving as a buffer zone between the street and the spaces for the use of the family.

The family sector is mostly found as a c-type space (*Tb*, *Tc*, *Tf* and *Th*), appearing in four graphs, but corresponding to 35.71% of the sample. It is found as a b-type space in three graphs (*Ta*, *Td* and *Te*), corresponding to 57.14% of the colonial houses. This result is an effect of the composition of the sample, as highlighted above, but it does describe the 'hierarchical' structure of these houses, in which the processional passage from one sector to the other is made by sequential and controlled steps. The family sector is also found as an a-type space in House C14 (graph *Th*). In this house, the family sector is split into two nodes, one at the first floor and the other at the attic. The secondary family sector (f1) assumes the form of a b-type space, therefore confirming the tendency of the family sector in assuming depth maximising positions.

The service sector is the most consistent of all. It is mostly found as an a-type space (six graphs corresponding to 78.57% of the houses). The remaining two graphs (*Tb* and *Tc*) are c-type spaces (21.43% of the houses), as a result of either an alternative access directly from the street to the service zone (C9 and C10) or the connection between outdoors visitors' and service spaces. (C7). However, the most important characteristic of the service sector is its multiplication in the household, in order to provide both isolation of the male slaves from the family realm and the proximity of the female slaves to the same family realm, in order to provide all necessary assistance to household members.

Secondary service sectors confirm the tendency of the service sector in being characterised as an isolated and occupational sector without movement through its premises. The secondary service sectors (se1 and se2) are mostly a-type space (four graphs which corresponds to 35.71% of the houses), but they also assume a c-type position in one graph (House C11) and a d-type in another graph (C13).

Finally, the public space is found in three situations. As an a-type space, in five graphs (*Ta*, *Tb*, *Td*, *Te* and *Th*), which corresponds to ten dwellings (71.43% of the sample). It is also found in the same rings which include visitors' and family sectors. It appears as a c-type in one graph (*Tc*) and as a d-type in two graphs (*Tf* and *Tg*). This d-type position is given by the connection to the store, otherwise, the exterior would become a c-type space.

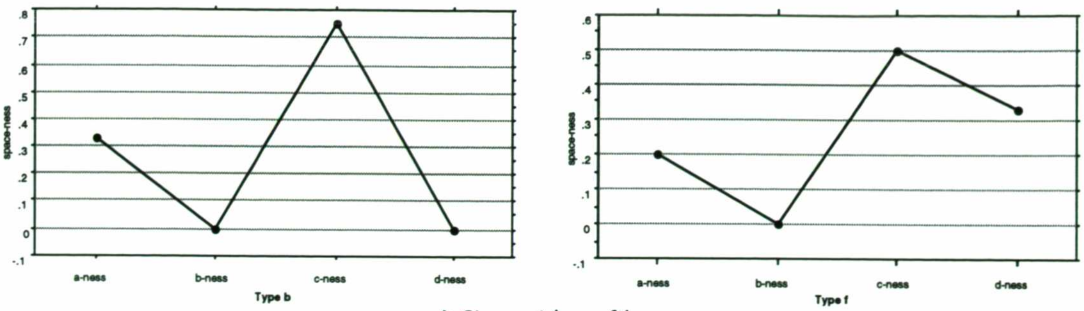
5.2.3.2.1. Space-type profiles

The space-ness profiles are less rich in variety than the ones provided by the modern sample (see figure 5.17. and table 5.5.). There are six different profiles, two non-existent amongst modern houses. The most popular profile amongst the graphs is the 'L-shape' one, with three occurrences (*Td*, *Te* and *Th*), present in four dwellings. It has the lowest DV, 2.31, amidst the profiles, but nevertheless this DV is very high. The second profile in terms of occurrence amongst the graphs is the 'sinusoid' one, present in two graphs (*Tb* and *Tf*) and two houses. It is slightly more differentiated than the 'L-shape' profile with MDV of 2.36.

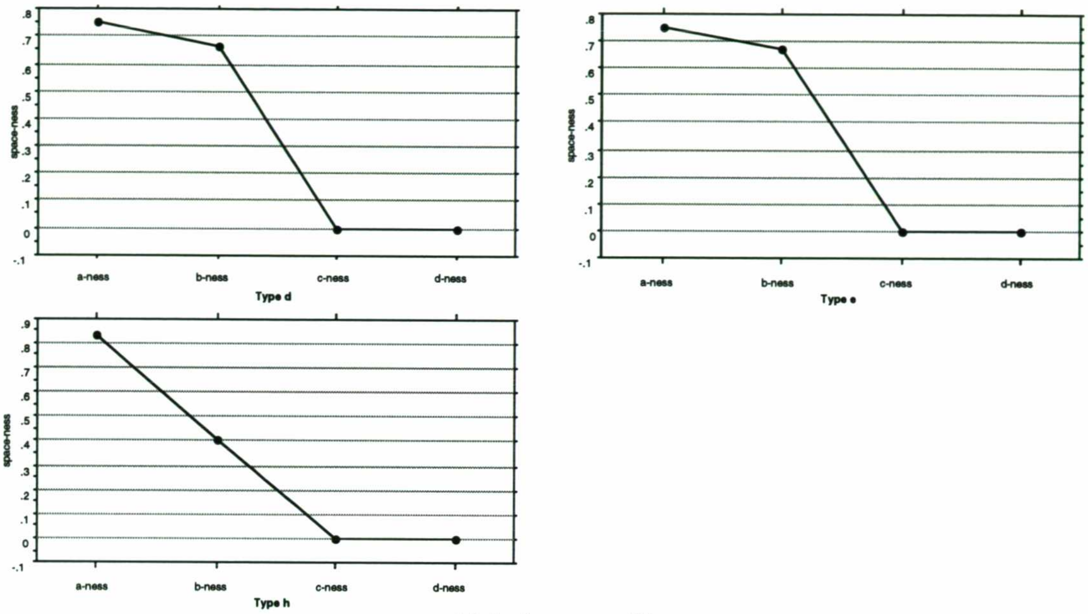
Table 5.5. The colonial space-type profiles

profile	types	inequality	graphs	houses	% sample	MDV
L-shape	Td/Te/Th	a>b>c=d	3	4	28.57	2.31
v-shape	Tg	a>b<c≤d	1	1	7.14	2.58
s-shape	Tc	a=b<c≥d	1	2	14.29	4.00
sinusoid	Tb/Tf	a>b<c>d	2	2	14.29	2.36
z-shape	Ta	a<b>c=d	1	5	35.71	2.40

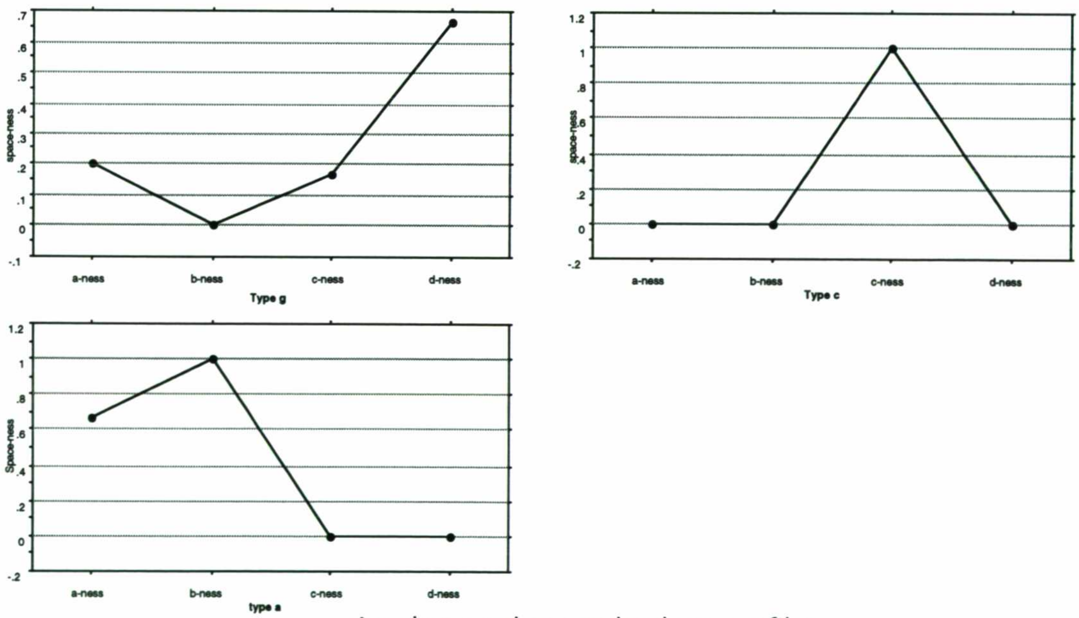
The remaining profiles, 'v-shape', 's-shape' and 'z-shape', are found in singular graphs (*Tg*, *Tc* and *Ta*, respectively). The 'v-shape' profile is the least popular (one house only) and it is well differentiated (2.58). The 's-shape' profile is found in two houses, and it presents the highest differentiation (4.00) for being exclusively composed by c-type spaces. The 'z-shape' is the most popular amongst the sample, with five occurrences. It presents a mean difference value (MDV) of 2.40, suggesting that the most popular profiles ('L-' and 'z-shape') are the least differentiated.



a) Sinusoid profile



b) L-shape profile



c) v-shape, s-shape and z-shape profiles

Figure 5.17. The colonial space-ness profiles

Figure 5.18. presents the rank order of the average value of space-ness for the colonial sample. The order *d<c<b<a* demonstrates how tree-like the colonial sectors' graphs are. This pattern indicates a high control of access from sector to sector, representing the oppressive domestic environment portrayed in

travellers' diaries and social studies reviewed in chapter four. This pattern contrasts with the rank order of space-ness value of modern houses, *b<a<d<c*, which, by being ringy, offers alternative routes of movement within the system.

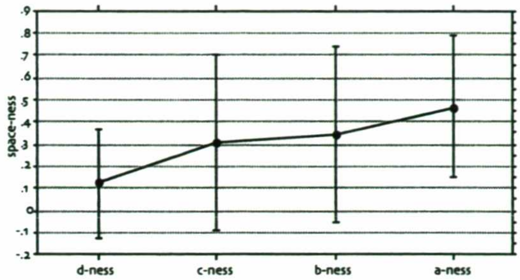


Figure 5.18. The genotypical colonial space-ness order

5.2.3.3. Depth analysis

Plotting the depth of each sector from the exterior reveals a consistent pattern (figure 5.19.). The visitors' sector is the shallowest sector in every graph, one step away from the exterior. The family sector follows the visitors' in sequence, in all cases, being two steps from the street. The secondary family sector is found in the same position. This pattern clearly describes the colonial domestic structure, which places the family realm apart from the street and positions the visitors' zone closer to the street. What is remarkable in this pattern is that it is invariably found, regardless of houses' area, social class or type (terraced, detached or semi-detached).

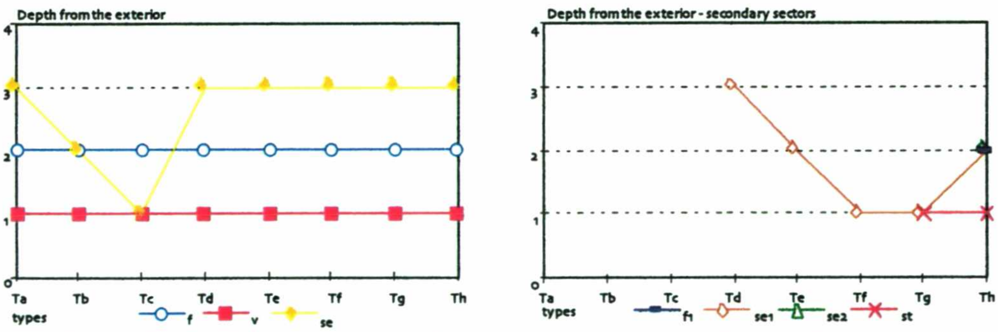


Figure 5.19. Colonial sectors' depth: a) main sectors, b) secondary sectors

The service sector, however, is found in three different situations. In graphs *Ta* and *Td* to *Th*, it is the deepest sector of all, corresponding to eleven dwellings (78.57%). In two cases (14.28%), represented by graph *Tc*, the service sector is as shallow as the visitors' sector, due to a secondary access to the houses, and in a single case (graph *Tb*), it is two steps from the street. The secondary service sectors (se1 and se2), follow a similar pattern. They appear in graphs *Td* to *Th*, varying from one to three steps from the street. In summary, it seems that the relative position of the service sectors is defined in order to attend to the family's requirements, for example, by positioning the male slaves quarters shallow from the street or by placing the kitchen and female slaves quarters deep inside the house.

Figure 5.20. plots the mean depth of each sector. The values picture with accuracy the ideal patriarch house: visitors are situated at the periphery of the complex, the family is isolated from the street and the service sector is the deepest of all, but as it is split into secondary units, it allows positioning slaves in the adequate position to serve visitors and family members.

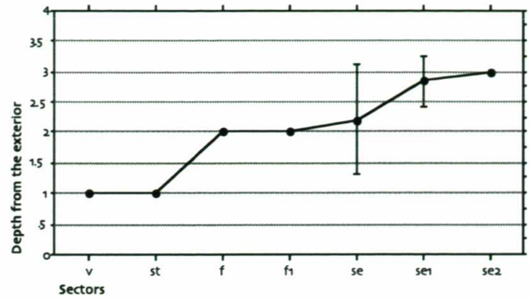


Figure 5.20. Colonial sectors' depth

5.2.3.4. Integration analysis

Table 5.6. presents the rank order of integration of the colonial sectors, ordering the RRA values, from the most integrated to the most segregated, and table 5.7. isolates the main functional sectors, keeping their order of integration intact. The integration value of the main sectors is also plotted in the graphs shown in figure 5.21.

Table 5.6. The colonial rank order of integration (RRA)

Rank Order of RRA - All sectors

type	v	f	se	e			
Ta	0.999	=0.999	<2.999	=2.999			
	v	f	se	e			
Tb	0.000	<0.999	=0.999	<1.999			
Tc	0.999	=0.999	=0.999	=0.999			
	f	v	se	se1	e		
Td	0.474	<0.947	<1.839	=1.839	<2.367		
	v	f	e	se1	se		
Te	0.474	<0.947	<1.839	<1.894	<2.365		
	v	f	se1	e	st	se	
Tf	0.573	=0.573	<0.860	=0.860	<1.146	<1.719	
	v	f	se1	st	e	se	
Tg	0.573	=0.573	=0.573	<0.860	=0.860	<1.719	
	v	f1	se1	se2	e	f	se
Th	0.196	<0.785	<1.177	=1.177	=1.177	=1.177	<1.765

Rank Order of RRA - Main sectors

type	v	f	se	dv	cases	%
Ta	0.999	= 0.999	<2.999	1.20	5	35.71
	v	f	se			
Tb	0.000	< 0.999	=0.999	1.50	1	7.14
Tc	0.999	= 0.999	=0.999	0.00	2	14.28
	f	v	se			
Td	0.474	< 0.947	< 1.839	1.26	2	14.28
	v	f	se			
Te	0.474	< 0.947	<2.365	1.50	1	7.14
	v	f	se			
Tf	0.573	= 0.573	< 1.719	1.20	1	7.14
	v	f	se			
Tg	0.573	= 0.573	< 1.719	1.20	1	7.14
	v	f	se			
Th	0.196	< 1.177	< 1.765	1.50	1	7.14

Table 5.7. The colonial sectors' genotypes

Ga - v=f<se

	MRRA	DV	case	%
Ta	1.999	1.20	5	35.71
Tf	0.955	1.20	1	7.14
Tg	0.860	1.20	1	7.14
Mean	1.271	1.20		
Total			7	49.99

Gb - v<f<se

	MRRA	DV	case	%
Te	1.515	1.50	1	7.14
Th	1.07	1.50	1	7.14
Mean	1.291	1.50		
Total			2	14.28

Gc - v<f=se

	MRRA	DV	case	%
Tb	0.999	1.50	1	7.14
Mean	0.999	1.50		
Total			1	7.14

Gd - v=f=se

	MRRA	DV	case	%
Tc	0.999	0.00	2	14.28
Mean	0.999	0.00		
Total			2	14.28

Ge - f<v<se

	MRRA	DV	case	%
Td	1.515	1.26	2	14.28
Mean	1.515	1.26		
Total			2	14.28

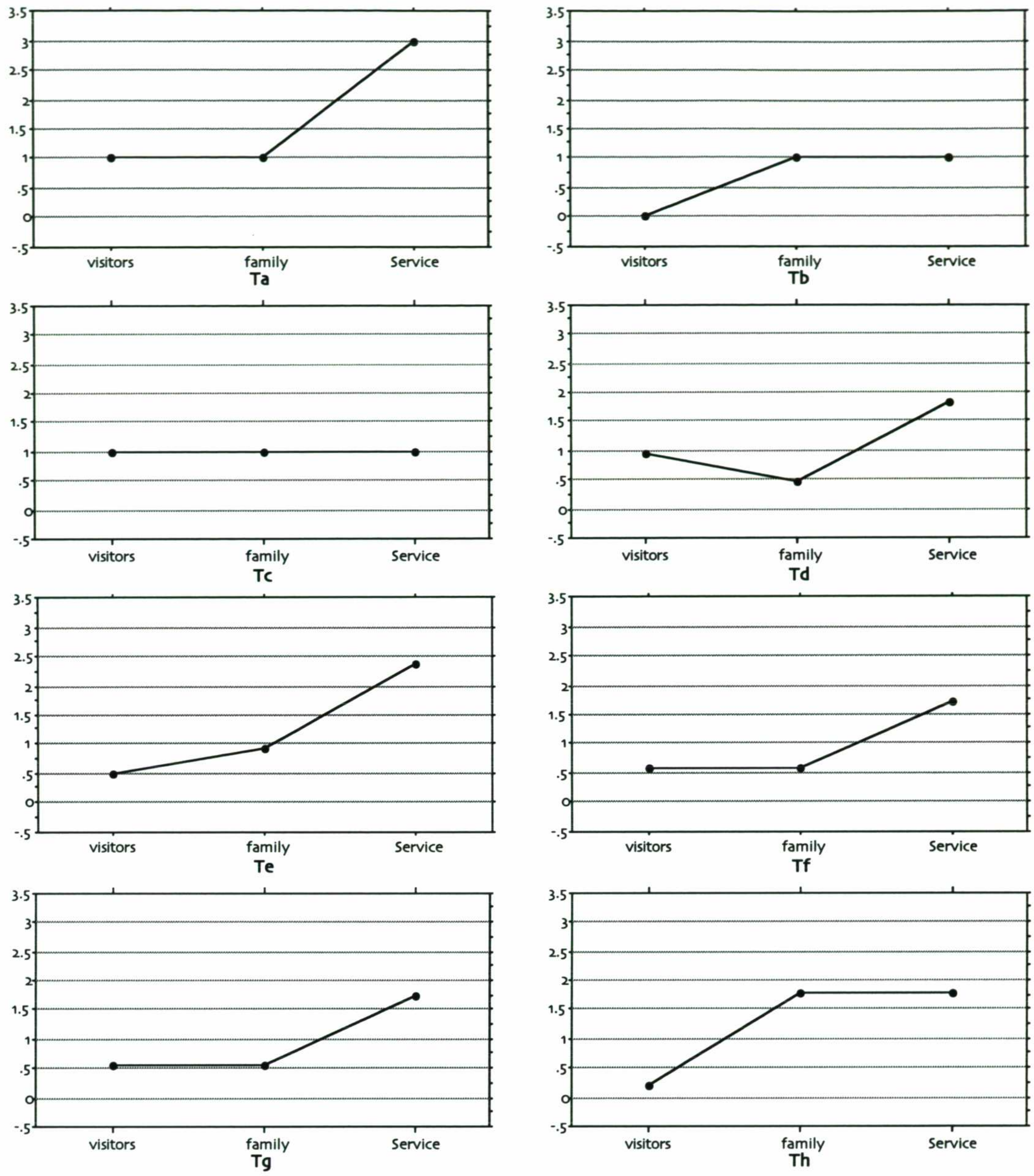


Figure 5.21. Rank order of integration of the main sectors

One clear characteristic of the sample is the high values of integration given to the visitors' sector, which is the most integrated node in seven out of eight graphs. In contrast, the service sector is found as the most segregated of all nodes in five graphs. The family sector maintains high levels of integration, being as integrated as the visitors' sector in four cases and the most integrated of all in one case.

The inequalities between the integration values form five different arrangements, one of them of extreme significance for their pervasiveness amongst the graphs and the dwellings themselves (table 5.7.). This genotype *a* is defined by the order v=f<se. It presents the second most integrated system (1.271) but it is not highly differentiated (DV of 1.20). It is found in graphs *Ta*, *Tf* and *Tg*, corresponding mostly to ground-floor-middle-class-terraced houses

(*Ta*). Genotype *b* is the second most popular amidst the graphs (*Te* and *Th*), but only found in two houses. It is slightly more integrated than genotype *a* (1.291), but it is significantly more differentiated (1.50).

The other exceptional genotypes are found in single graphs. Genotypes *d* and *e* are present in two houses each, while genotype *c* is present a single dwelling. Genotypes *c* and *d* are the most integrated types (0.999), and genotype *d* does not differentiate the sectors (0.00). The particularity of these genotypes is the high integration of the service sector

Despite visitors' and family sectors being equally integrated in the most popular sequence of inequalities, on average, the visitors' sector is the most integrated node within the colonial sample. This sector is followed by the family and service ones. This ordering may be considered the basic colonial sectors' model, from which the genotypical arrangements are derived (figure 5.22.).

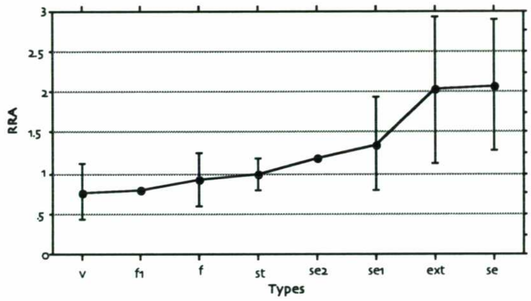


Figure 5.22. Colonial sectors' RRA values

5.2.3.5 The restrictive laws

The final part of the analysis looks at the rules that defined the types of arrangements found in the sample. The first general conclusion that can be drawn from the analysis is that the size and complexity of the graphs depends on the size and complexity of the houses themselves. Therefore, simple dwellings accommodate functions and categories of users into a fewer number of territories, whereas sophisticated residences create sub-sectors to attend particular requirements.

Secondly, each sector seems to perform a particular role in the configuration of the houses. The visitors' sector is the shallowest and the most integrated of all, being mostly found as a b-type space, but also as c- and d-type spaces. Despite these occurrences, its main role is to maximise depth, in order to isolate the territory of the family from the street. The family sector follows the visitors' sector in order of integration and also in the number of necessary steps from the street to access it. It is also mostly a b-type space, but the family sector assume a c-type position. This demonstrates the tendency of the main sectors in regulating movement through the system. The service sector is the most segregated and the deepest of all. This suggests that depth from the street and integration are combined to make deeper sectors more segregated and shallow sectors more integrated. The service sector is mostly found as an a-type space, demonstrating a general interest in isolating slaves territories. Moreover, generating secondary service sectors is the means to created distinctiveness. For example, the basic type *Ta* is systematically changed to types *Td*, *Te* and *Th* by separating the service spaces into different compounds. The public realm is amidst the most segregated nodes and is also mostly found as a-type spaces. This confirms the interest to keep the street apart from the household.

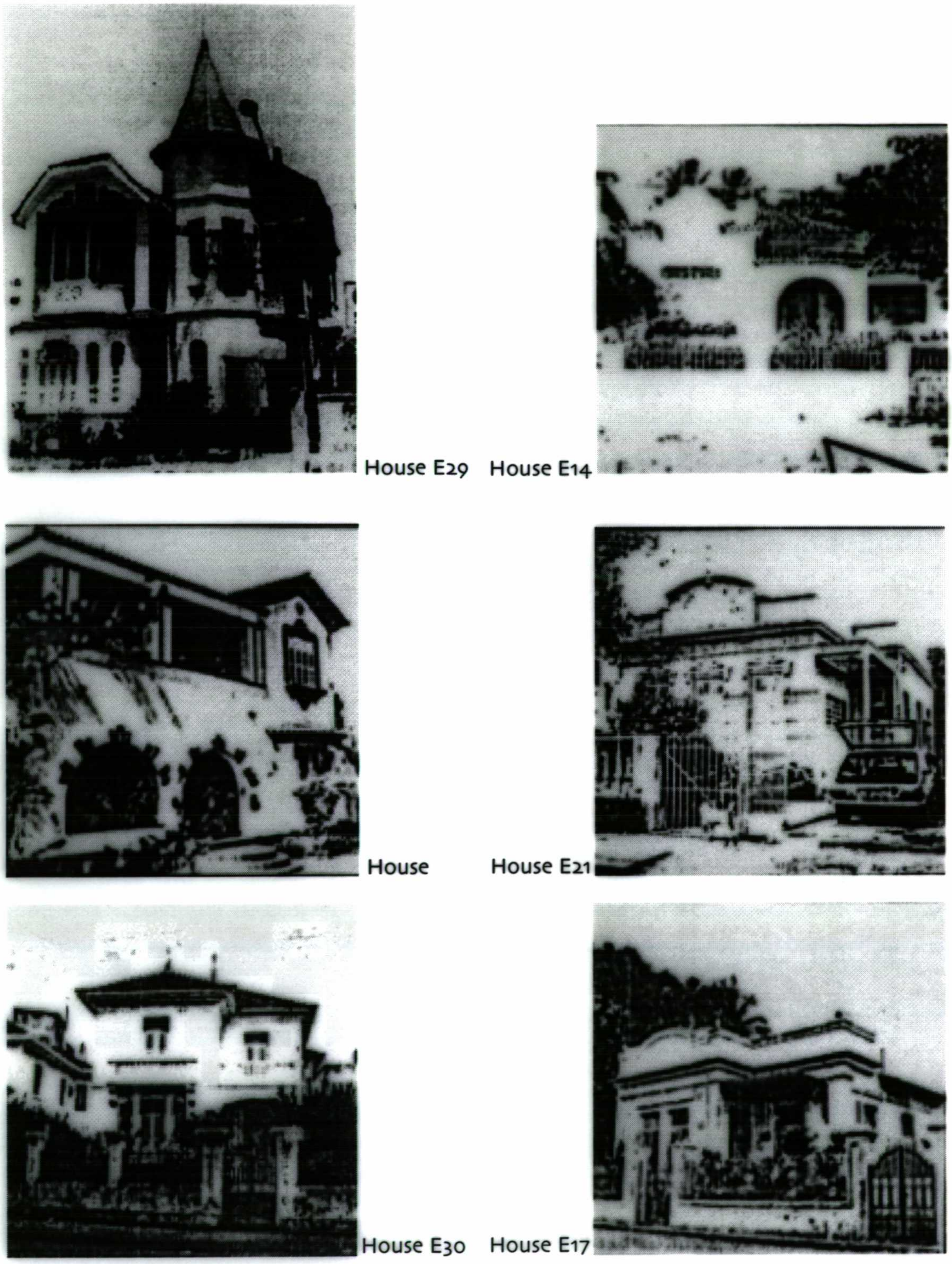
In summary, the houses seem to be arranged in order to attend some general requirements. The visitors' sector has to be placed in a shallow position, isolating, but also controlling access to the house. The family sector has to be positioned in a segregated position from the point of view of the street, served by the service sector and serving the visitors' one. The service sector has to be isolated, both to keep its distance from the visitors' eyes and to maintain family's privacy. This privacy is confirmed by keeping the public realm apart from the house. Finally, as a general rule, the more sophisticated housing program gets, the more complex the sectors' arrangement is.

5.3. The eclectic house

5.3.1. The sample and its sectors' representation

The eclectic sample is composed of thirty four dwellings, twenty two of which are ground-floor and twelve are multi-level (see figure 5.23. and attached laser disk). The vast majority of the eclectic houses are detached from the plots' boundaries (58.82%), because of the suburbanisation of the city and the hygienic requirements for light and air inside the house. Semi-detached houses are also significantly found in the sample (29.41%) and terraced dwellings are reduced to four cases (11.76%).

The houses included in the sample are the ones which the available plans were originally submitted for building approval, therefore more reliable than the existing plans of colonial houses. Nevertheless, the eclectic houses also demand a careful discussion on the way space, activities and users were orchestrated, and how domestic sectors were represented in this study. As transitional houses, corresponding to the period between the fall of the patriarchy and the establishment of the modern nuclear family in Brazilian



House E29 House E14

House House E21

House E30 House E17

Figure 5.23. The eclectic dwellings

society, the eclectic houses show a certain instability in the way kinds of functions are treated and spaces used. On the one hand, the pattern front-visitors/middle-family/back-service is still very much present, but on the other hand, visitors' and family spaces are closer. Moreover, some eclectic houses start to isolate the rooms for individual privacy from the ones for the communal use of the family, as a preview to the modernist private sector.

These instabilities in domestic organisation made the identification of domestic sectors more difficult. In order to clarify some of the procedures used to represent sectoring in these houses, two exemplars were detached from the sample in order to discuss their features and define the representational procedures used in this research.

The eclectic *casa térrea* could not be more different from the typical terraced colonial house. Freed from the narrowness of the urban plots, these dwellings were located in the centre of the sites, opening up the old alcoves to receive fresh air and enjoy the view of the domestic suburban gardens (figure 5.24.). Its internal layout also suffered an impressive transformation. The most significant of all was the disappearance of the central corridor and consequent approximation of the visitors room to the *sala-de-jantar* or dining room. This radical transformation of houses' layout, blurred the previous stable polarity front/formal and back/informal-service.

Even though these spaces became geometrically and topologically closer, there was still the need to keep the receiving rooms shallow from the point of view of the visitor and enclosed by doors. This strategy not only kept access of visitors to a strict area of the house, but also allowed, by opening and closing doors, the transformation of the houses in order to adapt themselves to different use conditions. This is more evident in the role of the thoroughfare bedrooms as an alternative passage from the family area to the receiving rooms, and amidst family rooms, without being disturbed by visitors' presence.

This diachronic use of the space is, perhaps, the most striking characteristic of the ground-floor eclectic dwellings. For example, by keeping the visitors'/dining room door closed, inhabitants were able to maintain the visitors' room as tidy as possible, with its display of all family richest possessions. On the other hand, by opening the door, inhabitants extended the visitors' area during a formal reception. And during these occasions the *copa* was fundamental to isolate the kitchen and all service noises and nuisances from the senses of the visitor. And because of this flexibility in house use, imagining the house as being sectored is put into question. However, if the house is observed when the distinctive categories of users are synchronically present in the house, then it becomes clear that the spatial system was planned to establish determined territories for each category.

This is better understood by observing one of these houses. Figures 5.24. and 5.25. show the plan of House E12 and its sectors' representation. The visitors' sector is composed of the front garden, terrace and visitors' room. Only informal guests would access beyond this point. The composition of the family sector is singular. It includes all bedrooms, dining room and *copa*. The layout of the sector is most peculiar. The main bedroom is connected to the front terrace, allowing a secluded entrance to the house, when an unexpected visitor is being entertained in the front room. From the main bedroom, any member of the family would have access, through one of the bedrooms, to the dining room. This would give the opportunity either to furtively skip guests' presence or to get ready to receive them. The service sector maintains the colonial arrangement, but the appearance of an *edícula* gives to the eclectic dwelling its particular identity. The sectors' configuration of the house assumes the form of a deep tree, ordered from the shallowest visitors' sector to the deepest service one, as seen in the colonial dwellings. It seems that the layout of the houses have changed, but the basis for their solution seems to be the same.

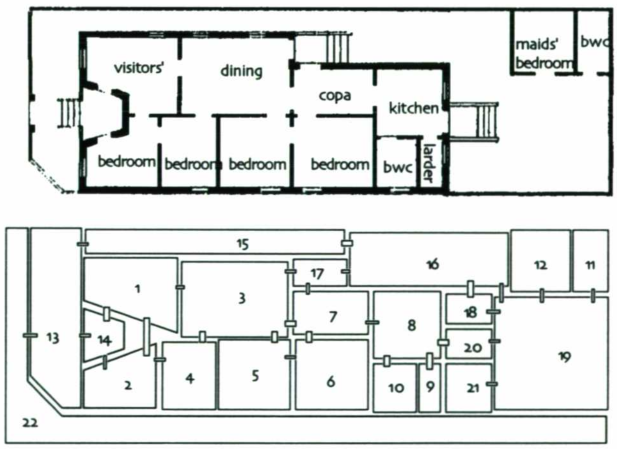


Figure 5.24. House E12: plan and convex break up

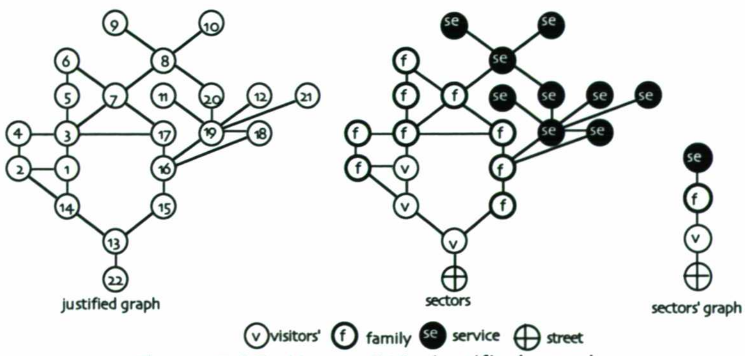


Figure 5.25. House E12: justified graphs.

The multi-level eclectic dwellings, however, present a more complex scenario. House E25 (figures 5.26 and 5.27) is a distinctive Victorian house, built in the suburb of Boa Vista. Some of its features are typical of the transition between the colonial and the modern dwellings. It presents isolation and shallowness of the visitors' rooms of the colonial houses, but already introduces one of the most important characteristics of the modern houses, which is the segregation of the spaces for individual privacy in a deep and isolated zone of the house.

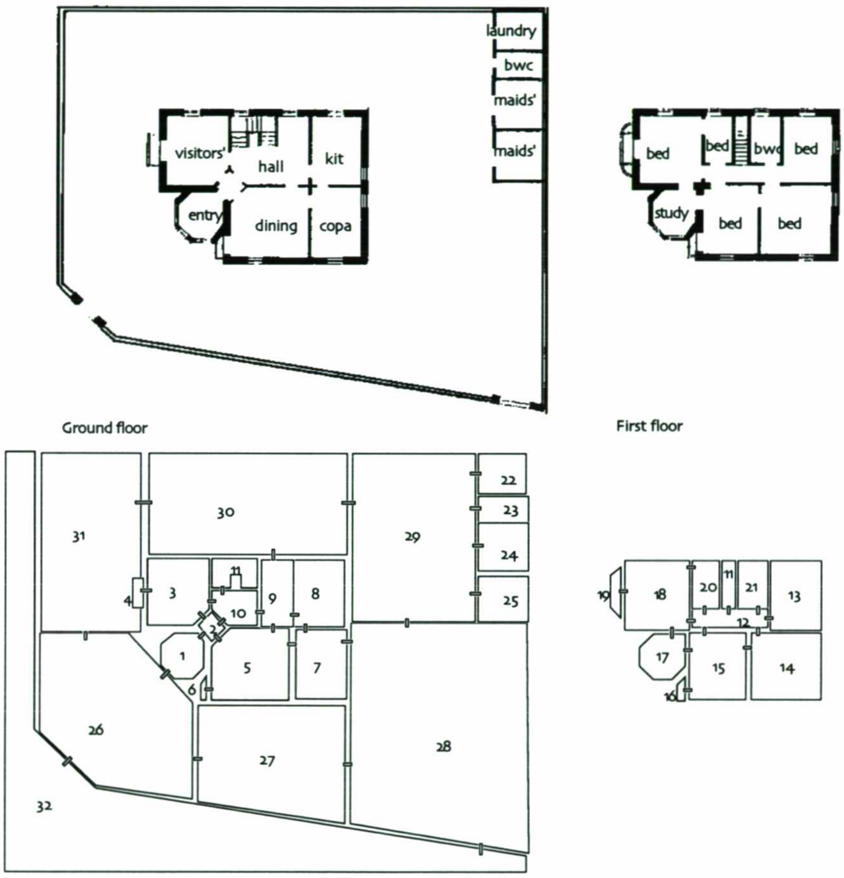


Figure 5.26. House E25: plan and convex break up

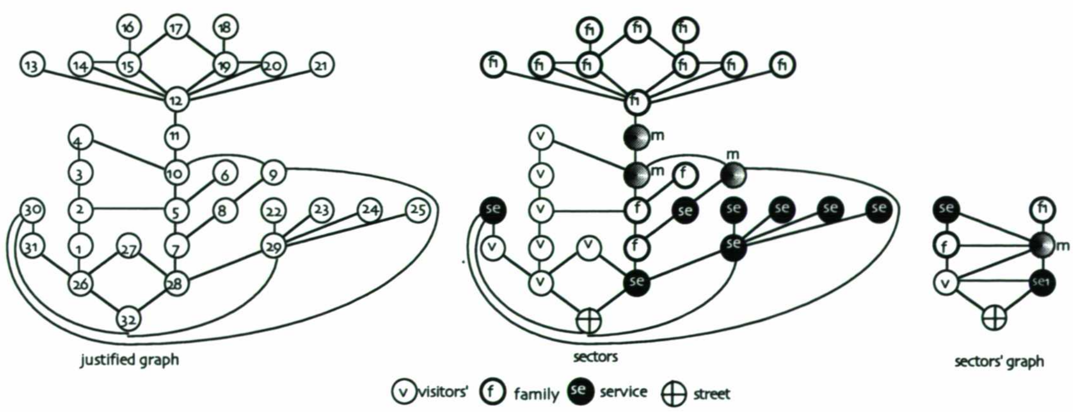


Figure 5.27. House E25: justified graphs.

Another important aspect to be noted is the use of a sophisticated network of transitional spaces that crosses the whole dwelling, from the garden to the top floor, not to be seen in the ground-floor eclectic residences. Transitionality, however, is not a novelty introduced by the eclectic dwellings. Colonial houses, as seen in section 5.2., already used them. What differentiates them is how the transitional spaces are used. In the colonial houses, transitional spaces connected rooms of the same sector, whereas in the eclectic dwellings, some transitional spaces are used to isolate and connect spaces from different sectors. In other words, they are used as mediator sectors.

This aspect is perfectly seen in House E25. The core of the house, formed by the staircase and the ground floor transitional spaces, mediates the access to the main sectors of the house. This indicates a similarity with the modernist housing solution. However, the eclectic housing layout is distinguishable from the modern one by the combination of an extensive network of transitional spaces with thoroughfare rooms. Indeed, this seems to be the main characteristic of these dwellings and the first floor plan of House 25 is a clear example of this typical solution.

The sectors' organisation of House 25 is quite complex (figure 5.27). This is due to three factors. Firstly, the isolation of the private bedrooms on the first floor; secondly, the use of mediation; and thirdly the unusual isolation of the kitchen from the set of service spaces. This 'internalised kitchen' will only be seen again in a single modern house (M162).

5.3.2. General properties

Table 5.8. presents the general characteristics of the eclectic houses, concerning their topological and geometrical sizes, their architectural features, as well as the results of the syntactic analysis. The houses are organised according to their height and topological size.

One clear distinction between the colonial and eclectic sample is their location in the city. The eclectic dwellings are predominantly situated in the suburbs of Recife, which corresponds to the expansion of the city in the turn of this century, whereas the colonial sample is predominantly situated in urban areas. The majority of the eclectic houses is situated in Espinheiro (25%) and Derby (12.5%), suburbs located at the fringes of the older and denser Boa Vista, but the sample also collects cases situated in the more remote suburbs of Casa Amarela (3 cases) and Casa Forte (1 case). Even though the eclectic dwellings are more likely to be found in the suburbs of the city, 25% of the sample is

Table 5.8. The eclectic houses:general and syntactic data

House		Location		House				Area		Width	Convex	spaces				Graph			visitors			family			family 1			service			service 1			mediator			exterior		
	address	district	locality	C*	types	st	fl	plot	house	plot	all	house	ed	In**	out	T	size	MRRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA
E1	Iraja, 464	fourth	Torre	mc	s-det	grd	1	188.0	89.0	6.6	16	9	1	10	6	Ta	4	1.999	b	1	0.999	b	2	0.999				a	3	2.999							a	0	2.999
E2	Sossego, 53	first	Boa Vista	mc	ter	grd	1	149.0	97.0	6.6	16	10	2	12	4	Ta	4	1.999	b	1	0.999	b	2	0 999				a	3	2.999							a	0	2.999
E3	Br. de Itamaraca, 27	third	Espinheiro	mc	s-det	grd	1	230.0	87.0	10.0	17	10	1	11	6	Tb	4	1.999	b	1	0.999	b	2	0.999				a	3	2.999							a	0	2.999
E4	Manoel Borba, 401	first	Boa Vista	mc	s-det	grd	1	320.0	136.0	11.0	18	9	3	12	6	Tb	4	1.999	b	1	0.999	b	2	0.999				a	3	2.999							a	0	2.999
E5	Pernambucanas, 120	first	Derby	mc	ter	grd	1	140.0	98.0	6.0	18	8	3	11	7	Ta	4	1.999	b	1	0.999	b	2	0.999				a	3	2.999							a	0	2.999
E6	Sossego, 67	first	Boa Vista	mc	s-det	grd	1	216.0	120.0	11.0	18	12	3	15	3	Ti	4	1.999	b	1	0.999	b	2	0.999				a	3	2.999							a	0	2.999
E7	Baixa Verde, 441	first	Derby	mc	s-det	grd	1	180.0	94.0	6.0	19	11	2	13	6	Ta	4	0.999	c	1	0.000	c	2	0.999				c	2	0.999							a	0	1.999
E8	Graças, 892	first	Graças	mc	det	grd	1	501.0	130.0	13.0	19	10	1	11	8	Ti	4	0.999	c	1	0.000	c	2	0.999				c	2	0.999							a	0	1.999
E9	Ada Vieira, 33	fourth	Casa Forte	mc	det	grd	1	343.0	144.0	14.0	20	7	3	12	13	Ta	4	0.999	c	1	0.000	c	2	0.999				c	2	0.999							a	0	1.999
E10	Graças, 262	first	Graças	mc	s-det	grd	1	202.0	87.0	13.0	20	7	2	9	11	Ti	4	0.999	c	1	0.000	c	2	0.999				c	2	0.999							a	0	1 999
E11	Principe, 464	first	Boa Vista	mc	s-det	grd	1	275.0	156.0	9.0	20	10	3	13	7	Tc	4	0.999	c	1	0.000	c	2	0.999				c	2	0.999							a	0	1.999
E12	Lima, 327	first	Santo Amaro	mc	s-det	grd	1	280.0	168.0	9.0	21	10	2	12	9	Tc	4	0.999	c	1	0.000	c	2	0.999				c	2	0.999							a	0	1.999
E13	Quarenta e Oito, 334	third	Espinheiro	mc	det	grd	1	287.0	93.0	15.4	22	8	5	13	9	Tj	4	0.999	c	1	0.000	c	2	0.999				c	2	0.999							a	0	1.999
E14	Buenos Ayres, 125	third	Espinheiro	mc	det	grd	1	475.0	106.0	13.6	23	8	3	11	12	Tb	4	0.999	c	1	0.999	c	2	0.999				c	1	0.999							c	0	0.999
E15	Br. de São Borja, 480	first	Boa Vista	hmc	det	grd	1	420.0	185.0	11.0	24	12	3	15	9	Tb	4	0.999	c	1	0.999	c	2	0.999				c	1	0.999							c	0	0.999
E16	Carlos Gomes, 529	fourth	Madalena	mc	det	grd	1	348.0	142.0	12.0	24	10	4	14	10	Tb	4	0.999	c	1	0.999	c	2	0.999				c	1	0.999							c	0	0.999
E17	Arraial, 3764	third	Casa Amarela	mc	det	grd	1	696.0	105.0	15.0	25	12	4	16	9	Tc	4	0.999	c	1	0.999	c	2	0.999				c	1	0.999							c	0	0.999
E18	Cons Portela, 609	third	Espinheiro	mc	s-det	grd	1	352.0	137.0	11.0	25	12	3	15	10	Ta	4	0.500	d	1	0.000	d	1	0.000				c	2	0.999							c	0	0.999
E19	Cons. Portela, 560	third	Espinheiro	mc	det	grd	1	481.0	153.0	14.0	25	10	4	14	11	Ti	4	0.500	d	1	0.000	d	1	0.000				c	2	0.999							c	0	0.999
E20	Rosa e Silva, 258	fourth	Espinheiro	uc	det	grd	1	933.0	218.0	17.4	26	11	4	15	11	Ti	4	0.500	d	1	0.000	d	1	0.000				c	2	0.999							c	0	0.999
E21	Br. de Itamaraca, 345	third	Espinheiro	hmc	det	grd	1	578.0	181.0	11.2	30	12	8	20	10	Tb	4	0.500	d	1	0.000	d	1	0.000				c	2	0.999							c	0	0.999
E22	Manoel Borba, 440	first	Boa Vista	mc	det	grd	1	612.0	204.0	15.0	31	13	6	19	12	Tb	4	0.500	d	1	0.000	d	1	0.000				c	2	0.999							c	0	0.999
E23	Baixa Verde, 403	first	Derby	mc	ter	lvl	2	177.0	124.0	5.6	19	10	2	12	7	Tc	4	0.500	d	1	0.000	c	2	0.999				d	1	0.000							c	0	0.999
E24	Pça do Derby, 223	first	Derby	hmc	ter	lvl	2	155.0	100.0	5.6	24	18	0	18	6	Trr	6	0.955	d	1	0.573	d	1	0.287	a	3	1.719	a	2	1.433				c	2	0.573	c	0	1.146
E25	Paissandu, 189	first	Paissandu	uc	det	lvl	2	605.0	255.0	19 6	31	21	4	25	6	Tp	6	0.768	d	1	0.573	d	1	0.287	a	3	1.719	c	1	1.146				c	2	0.573	d	0	0.860
E26	Futuro, 14	first	Aflitos	hmc	det	lvl	2	551.0	220.0	14 0	32	16	6	22	10	Tn	6	1.146	c	1	0.287	c	2	1.146	a	3	2.005	c	2	1.146				b	2	0.860	a	0	1.433
E27	Amaury de Medeiros, 20(	first	Espinheiro	uc	det	lvl	2	530.0	294.0	15 6	33	16	4	20	13	To	6	1.337	c	1	0.860	c	2	0.573	a	4	2.292	c	2	1.146				b	3	1.146	a	0	2.005
E28	Fernandes Vieira, 292	first	Boa Vista	uc	det	lvl	2	1820.0	310.0	14.0	37	19	7	26	11	To	6	1.337	c	1	0.860	c	2	0.573	a	4	2.292	c	2	1.146				b	3	1.146	a	0	2.005
E29	João de Barros, 236	first	Boa Vista	uc	det	lvl	2	640.0	327.0	21.0	39	23	4	27	12	Tk	6	0.955	d	1	0.287	d	2	0.573	a	3	1.719	c	2	1.146				c	2	0.573	a	0	1.433
E30	Paissandu, 257	first	Paissandu	uc	det	lvl	2	770.0	345.0	15.0	39	21	5	26	13	Tl	6	0.955	d	1	0.287	d	2	0.573	a	3	1.719	c	2	1.146				c	2	0.573	a	0	1.433
E31	Feliciano Gomes, 262	first	Derby	uc	s-det	lvl	2	496.0	300.0	12.6	43	28	4	32	11	Tn	6	0.955	d	1	0.287	d	2	0.573	a	3	1.719	c	2	1.146				c	2	0.573	a	0	1.433
E32	Arraial, 2278	third	Casa Amarela	uc	det	lvl	2	1008.0	401.0	21.0	48	24	11	35	13	To	7	0.729	d	1	0.393	d	2	0.588	a	3	1.178	c	3	0.981	d	1	0.589	d	2	0.196	c	0	1.178
Mean all								467.44	175.19	12.34	25.69	13.03	3.66	16.75	9.09																								
	ground							373.00	133.18	11.40	21.68	10.05	3.18	13.32	8.59																								
	levels							675.20	267.60	14.40	34.50	19.60	4.70	24.30	10.20																								

* After Trigueiro, 1994 ** Indoors convex spaces include the house and the edícula

det=detached; s-det=semi-detached; ter=terraced; grd=ground; lvl=levels formed by houses built in Boa Vista, either as a result of constructions in the interstices of the colonial urban fabric or the modernisation of existing properties.

Another clear distinction between the two samples is the typology assumed by the dwellings. If the colonial houses are terraced, the eclectic ones are predominantly detached and semi-detached. The eclectic detached houses comprise 56.25% of the sample and the semi-detached ones correspond to 31.25%, but a few terraced houses are found in the suburbs of Derby (3 cases) and Boa Vista (1 case). Another particularity of the eclectic sample is the average number of floors per unit. The eclectic houses do not exceed two floors, whereas the colonial *sobrados* included in the sample vary from two to four storeys. It is certain that the availability of area offered by the suburban sites was fundamental to establish a substantial shift in the traditional house form, allowing the isolation of the building from the limits of the plot and a substantial increase in the plan area.

However, on average the colonial houses are larger than the eclectic ones. The average eclectic house area is 175.18m^2 (ranging from 87.00m^2 to 401.00m^2), whereas that of the colonial houses is 210.00m^2. This is because the average value of the colonial houses is pulled up by the 'Wealthy man' house, the largest of the sample with 840.00m^2. If this house is not taken into account, the average area for the colonial house would become 162.54m^2.

Ground floor eclectic houses are, on average, smaller than multi-level dwellings. The values for the first is 133.18m^2 whereas for the second is 267.60m^2. This pattern is also found amongst colonial houses, therefore confirming travellers' comments on the relationship between household wealth with verticality of the building.

Plot area of the eclectic houses is larger than the colonial ones. Eclectic houses have on average a plot area of 467.43m^2, which is more than double the size of the colonial dwellings (215.70m^2). Ground floor eclectic dwellings have smaller plots than multi-level ones. The first have, on average, a plot area of 373.00m^2, whereas for the second the plot area is 675.20m^2. These values reflect the extension of Recife's urban fabric to the continent, where land was more available. It also reflects the principle of a more hygienic lifestyle, close to nature and with availability of air and sun in and about the house.

Within the eclectic sample, house area has a better and significant correlation with plot size than within the colonial sample, which are 0.499r^2 (p=0.0001) and 0.011r^2 (p= 0.9461), respectively (see figure 5.28.). This is because, amongst colonial houses, area increased with the verticality of the building, as plots were small. This correlation values also demonstrates that even though area was more available at the fringes of the town, the plot prices were high. Indeed, the average plot area for the ground-floor eclectic dwellings, mostly occupied by middle-class families, is 326.00m^2, while the same value for the multi-level houses, mostly occupied by high-middle-class and upper-class families, is 702.83m^2.

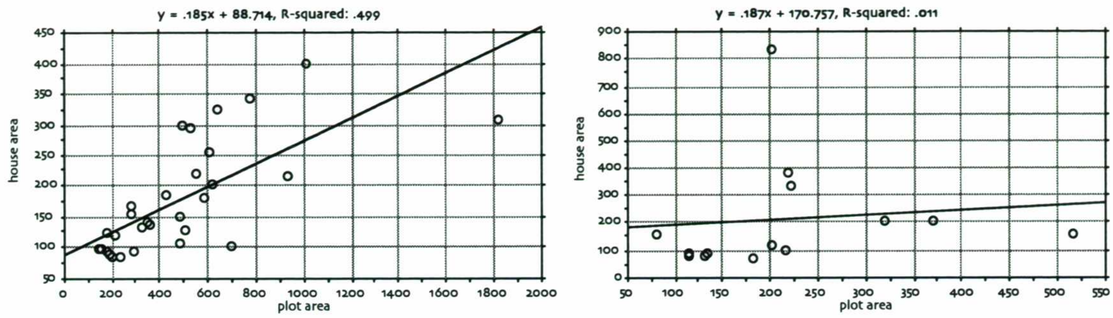


Figure 5.28. Correlation between plot and house areas: a) eclectic houses b) colonial houses

Topologically colonial houses are on average more convexially articulated indoors (18.07) than eclectic ones (16.75), because of the degree of interiority and verticality of the *sobrados*. Again, as a result of the unusual size of the 'Wealthy man' house (C14) the average value for the colonial houses is bigger than for the eclectic ones (18.21 against 16.97). Without counting with this unusual colonial exemplar, the average value becomes 15.62 and therefore is smaller than the value for the eclectic ones.

Eclectic dwellings are, on the other hand, more convexially articulated when the whole complex is counted (25.69 against 22.21). These differences are better understood when ground-floor and multi-level dwellings are compared. Colonial ground-floor dwellings are less articulated indoors (12.44 against 13.32) and as a whole (16.11 against 21.68), however they are more convexially articulated indoors (28.20 against 24.30) but not so as, a whole (33.20 against 34.50 for the eclectic).

Topological and geometrical size present a strong and significant correlation, as seen in the previous two samples of colonial and modern houses. The correlation for house area and indoor convex spaces is 0.819r^2 (p=0.0001) and 0.865r^2 (p=0.0001) for the house area and the total number of convex spaces (figure 5.29.). Again, plot area is not a good indicator of house convexiality (figure. 5.30.). The correlation for indoor spaces is 0.400r^2 (p=0.0001), whereas for the whole complex is just 0.473r^2 (p=0.0001).

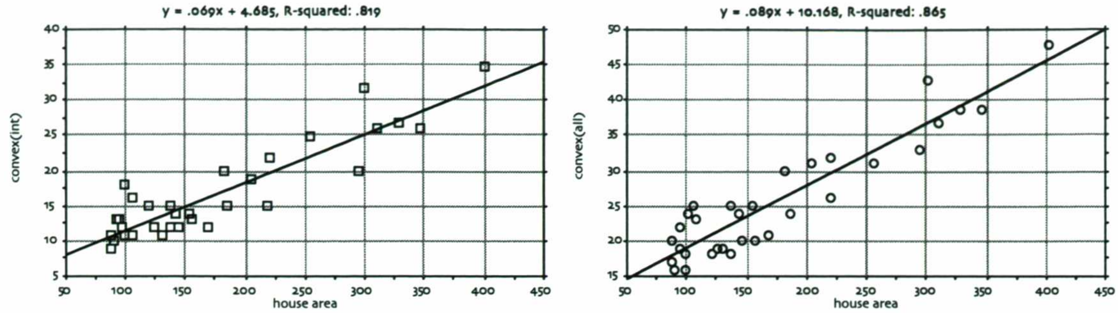


Figure 5.29. Correlation between house area and convex articulation:
a) indoors b) whole complex

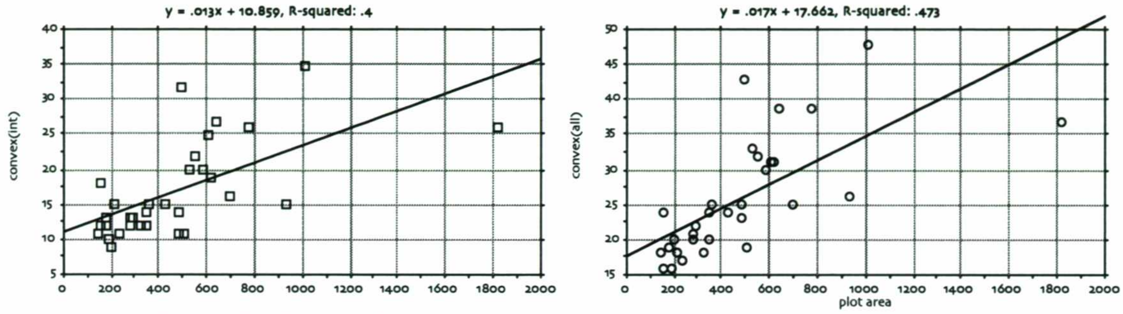


Figure 5.30. Correlation between plot area and convex articulation:
a) indoors b) whole complex

Other metric properties of the plot, like width, and architectural features of the houses, like number of floors, are not good indicators of houses' convexiality, conversely to what seen amongst the colonial dwellings. This is because the layout of the eclectic dwellings is freed from the constraints imposed by the site. Their architectural typology, however, are to a certain extent defined by plots width (correlation of 0.641r^2, p=0.0001) therefore, terraced houses are more likely to be found in narrow plots, whereas detached houses in wide plots (figure 5.31.).

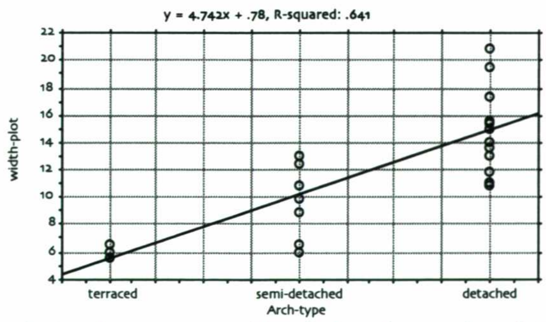


Figure 5.31. Correlation between width of the plot and architectural typology

Eclectic houses establishe a significant correlation between social class and geometrical (figure 5.32) and topological (figure 5.33) sizes. House area presents the best correlation with a value of 0.771r^2 (p=0.0001), but plot area does not (0.433r^2, p=0.0001). This may be resulted from the availability of large plots available in suburban areas for relatively low prices. Convexiality values are more consistent, albeit not as strong as house area correlation. The correlation values are $0.709r^2$ (p=0.0001) for indoor spaces and $0.694r^2$ (p=0.0001) for the whole complex.

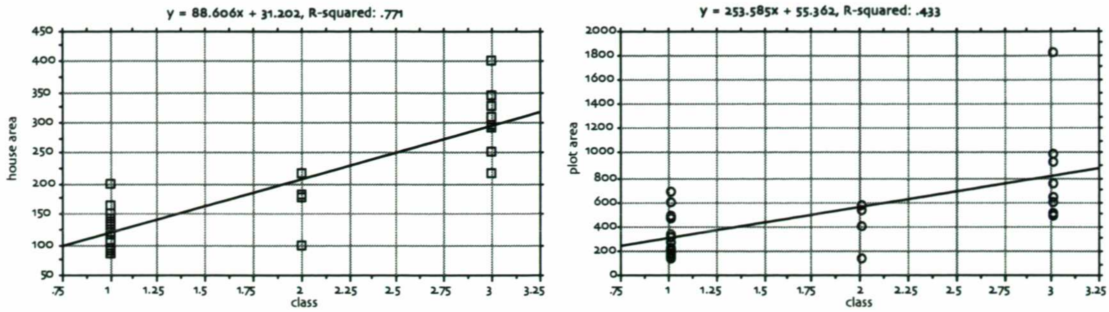


Figure 5.32. Correlation between social class and area: a) house b) plot

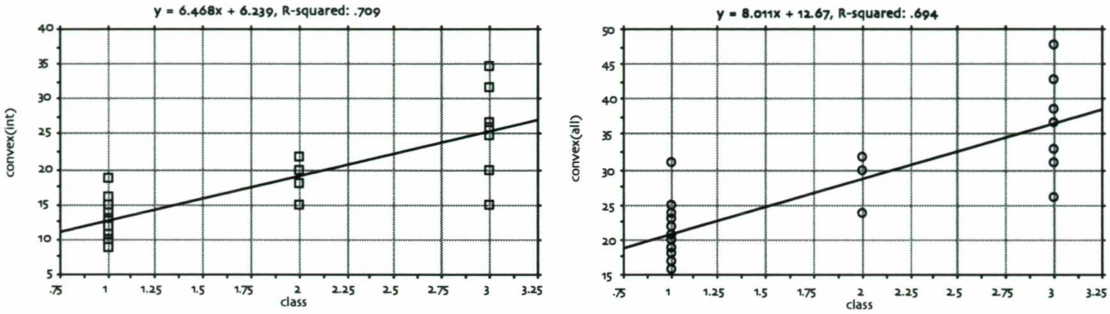


Figure 5.33. Correlation between social class and convexiality: a) indoors b) whole complex

5.3.3 The sector's analysis

The eclectic dwellings were organised into eleven different arrangements (figure 5.34.), with a ratio of 2.90 houses per graph. This value shows how speculative eclectic dwellings are, sectorwise, mainly if it is considered that the constraints which determined the sectors' configuration of the colonial houses, like the pervasive solution-typologies, are not present any longer. This speculative nature may be a consequence of the transition between the colonial and modern models. Indeed, eclectic dwellings present typical colonial arrangements, for example type *Ta*, and typical modern ones, such as type *Tn*, with the introduction of mediator units. Table 5.9. presents the data per sectors' graphs.

The arrangements *Ta*, *Tb* and *Tc*, are remains of the colonial times. They are found in seventeen cases (53.13% of the sample), mostly middle-class ground floor dwellings, either detached or semi-detached. This indicates that, even with availability of space and access, the colonial form of distributing activities and users are still present in the eclectic dwellings. Despite the substantial changes in style and layout, their overall functional structure falls into the same precedent order. The outstanding majority of middle-class dwellings in these sectors' types also signs the conservatism of the lower ranks of society.

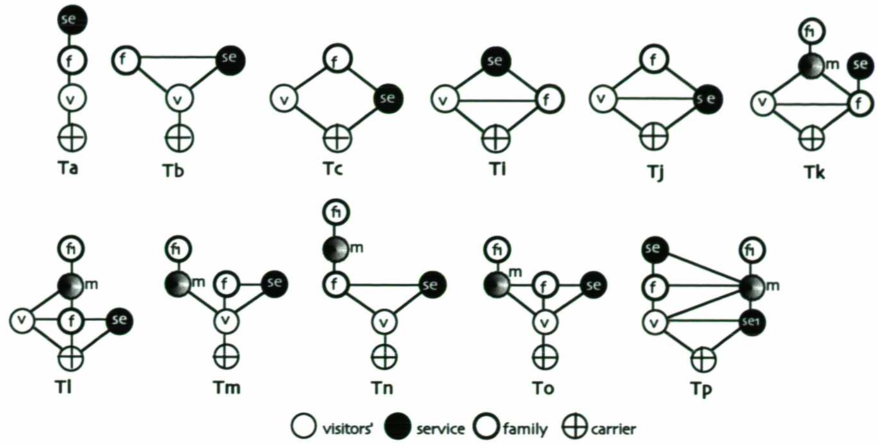


Figure 5.34. The eclectic sectors' graphs

Types *Ti* and *Th* are variations of type *Tc*. The first one represents the houses which introduce a direct access from the street to the family sector through the outside spaces for private entertaining of the household members. They are found in ground-floor dwellings, mostly middle-class (80%) and detached (60%). The second one, introduces an outside connection between visitors' and service sectors. This happens in a single case, a detached-ground-floor-middle-class house (E13), and even if access is possible, guests would never transgress their territory limits, unless invited.

Types *Tk* to *Tp* introduces mediator and secondary sectors. They are more complex graphs for the increase in number of nodes, but also because of the intricate connections which are constructed in some of the types (*Tp*, for example). These types are mostly found amongst detached-upper-class dwellings, organised in two storeys. They are also the least popular of the sample, corresponding to 28.13% citations.

Types *Tk*, *Tl* and *Tp*, present double and triple entrances for the houses, whereas types *Tm*, *Tn* and *To*, are accessed through the visitors' sector. The first group is found in upper-class-detached-multi-level dwellings, and the second group is more diverse in terms of architectural types (terraced, semi-detached and detached), but is always found in the upper stratum of society (high-middle and upper classes) and in levels.

The most significant characteristics of these second group of graphs is the presence of a mediator sector and the isolation of a secondary family sector. The mediator sector is composed of corridors, hallways, stairways and staircases, and performs the same role identified in modern dwellings, which is to isolate and manage the accesses amongst sectors. The secondary family sector is exclusively formed by the spaces dedicated to the individual members of the family. They are only found amongst multi-level dwellings.

These graphs indicate a significant change in houses' layouts. The colonial *sobrados* used to separate categories of users by floor, isolating the spaces for family use in one floor or floors, and the spaces for receiving guests in another floor, directly accessible form the street by means of a series of transitional spaces. The eclectic house proposes another kind of organisation. When verticality is required, the family and visitors' rooms are organised from the front to rear end of the ground floor plan, and the first floor is occupied by bedrooms. This important change in houses' layout is resultant from substantial changes in family structure, as pointed out in chapter four. They represent the slow emergence of the individuals in family structure, hence the need to isolate the spaces for individual use from the ones for the communal use of family members . It is important to note that the houses which present this layout are owned by wealthy families, therefore suggesting that the changes in Recife's social structure were first absorbed by the high ranks of society and also that the lower ranks of society were more conservative.

Table 5.9. The configurational properties of the eclectic graphs

Sectors									**visitors'**			**family**			**family 1**			**service**			**service 1**			**mediator**			**exterior**		
T	s	c	MRRA	a-ness	b-ness	c-ness	d-ness	DV	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA
Ta	4	6	1.999	0.67	1.00	0.00	0.00	2.40	b	1	0.999	b	2	0.999				a	3	2.999							a	0	2.999
Tb	4	7	0.999	0.33	0.00	0.75	0.00	2.77	c	1	0.000	c	2	0.999				c	2	0.999							a	0	1.999
Tc	4	4	0.999	0.00	0.00	1.00	0.00	4.00	c	1	0.999	c	2	0.999				c	1	0.999							c	0	0.999
Ti	4	5	0.500	0.00	0.00	0.50	0.50	2.00	d	1	0.000	d	1	0.000				c	2	0.999							c	0	0.999
Tj	4	1	0.500	0.00	0.00	0.50	0.50	2.00	d	1	0.000	c	2	0.999				d	1	0.000							c	0	0.999
Tk	6	1	0.955	0.40	0.00	0.33	0.33	1.51	d	1	0.573	d	1	0.287	a	3	1.719	a	2	1.433				c	2	0.573	c	0	1.146
Tl	6	1	0.768	0.20	0.00	0.33	0.50	1.94	d	1	0.573	d	1	0.287	a	3	1.719	c	1	1.146				c	2	0.573	d	0	0.860
Tm	6	1	1.146	0.40	0.25	0.50	0.00	1.74	c	1	0.287	c	2	1.146	a	3	2.005	c	2	1.146				b	2	0.860	a	0	1.433
Tn	6	2	1.337	0.40	0.25	0.50	0.00	1.74	c	1	0.860	c	2	0.573	a	4	2.292	c	2	1.146				b	3	1.146	a	0	2.005
To	6	3	0.955	0.40	0.00	0.33	0.33	1.51	d	1	0.287	d	2	0.573	a	3	1.719	c	2	1.146				c	2	0.573	a	0	1.433
Tp	7	1	0.729	0.10	0.00	0.29	0.57	2.21	d	1	0.393	d	2	0.588	a	3	1.178	c	3	0.981	d	1	0.589	d	2	0.196	c	0	1.178

s= size; c= cases; st=space type; d= depth from street

5.3.3.1. Graphs by size

The eclectic graphs are found in three sizes. The four element graphs are the most popular amongst the sample, corresponding to twenty three houses or 71.88% of the sample. They are found in five arrangements (*Ta* to *Tc* and *Ti* to *Tj*) formed by the visitors', family and service sectors, rooted by the exterior. They are mostly middle-class (86.96%) and detached (47.83%), and on average the smallest houses of the sample, both geometrically and topologically (see table 5.10). Their average sizes are 364.48m^2 and 132.78m^2, for plot and house areas, and 13.26 and 21.56, for indoors and the complex, respectively.

The six element graphs are found in eight houses (25% of the sample), corresponding to the graphs *Tk* to *To*. They are mostly detached-upper-class-multi-storey dwellings. This indicates that the size and complexity of the graphs do correspond to class inequalities. Moreover, the average geometrical and topological sizes confirm that the more complex, sophisticated and larger the houses are, the more likely to present larger and complex sectors' arrangements. Indeed, the average plot and house areas (746,25m^2 and 287,12m^2, respectively) and the number of the convex spaces, both indoors (25.75) and for the whole complex (36.87), are higher than the values presented by the four element graph houses.

The seven element graph (*Tp*) is found in a single dwelling (E26). Its complexity is unique in the sample. It is the only case to isolate a secondary service sector and to establish an intense connectivity amongst the sectors. This case confirms the general trend which determines the complexity of graphs on the basis of the geometrical and topological sizes of the house, as well as the wealth of their inhabitants.

Table 5.10. The eclectic general data by topological size

Size	cases		Social class			Levels		Type			Area (m2)		Convex spaces	
	total	%	mc	hmc	uc	grd	str	t	s-d	d	Plot	House	All	Interior n
4	23	71.9	20	2	1	22	1	3	9	11	364.48	132.78	21.57	13.26
6	8	25.00	0	2	6	0	8	1	1	6	746.25	287.13	36.88	25.75
7	1	3.13	0	0	1	0	1	0	0	1	605.00	255.00	31.00	25.00

mc=middle class; hmc=high-middle class; uc=upper class
t=terraced; s-d=semi-detached; d=detached

5.3.3.2. Space-type

Figure 5.35. shows the eclectic sectors' graphs labelled according to the occurrence of space-types. and table 5.11. summarises the results. As previously observed in the colonial sample, the eclectic sectors assume different positions in the graphs. The visitors' sector is found as a b-type space in a single graph (*Ta*), corresponding to 18.75% of the sample, as a c-type, in four graphs (*Tb*, *Tc*, *Tm* and *Tn*) corresponding to 43.75% of the cases, and as a d-type space in the remaining six graphs, with twelve citations (37.50%). Despite the significant number of b-type cases, the visitors' sector is predominantly found within rings.

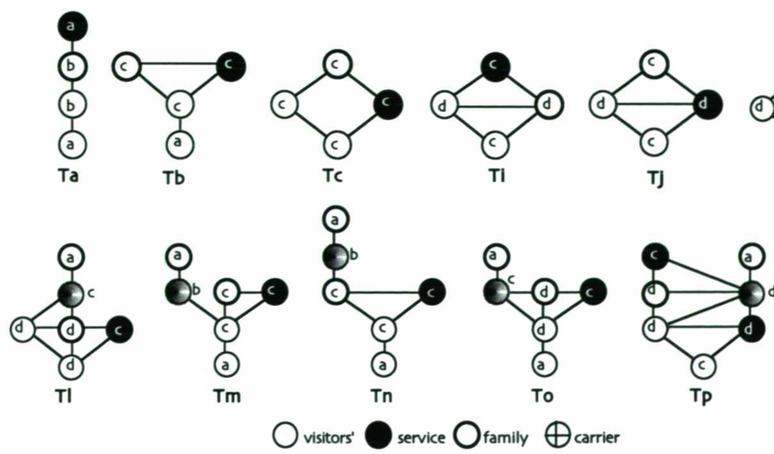


Figure 5.35. The eclectic graphs space type

Table 5.11. Space-types: occurrence in the eclectic sample

Sectors by space type - numbers per graphs														
type	v	%	f	%	f1	%	se	%	se1	%	m	%	e	%
a	0	0.00	0	0.00	6	100.00	2	18.18	0	0.00	0	0.00	5	45.45
b	1	9.09	1	9.09	0	0.00	0	0.00	0	0.00	2	33.33	0	0.00
c	4	36.36	5	45.45	0	0.00	8	72.73	0	0.00	3	50.00	5	45.45
d	6	54.55	5	45.45	0	0.00	1	9.09	1	100.00	1	16.67	1	9.09
Sectors by space type - cases in the sample														
type	v	%	f	%	f1	%	se	%	se1	%	m	%	e	%
a	0	0.00	0	0.00	9	28.13	7	21.88	0	0.00	0	0.00	19	59.38
b	6	18.75	6	18.75	0	0.00	0	0.00	0	0.00	3	9.38	0	0.00
c	14	43.75	15	46.88	0	0.00	24	75.00	0	0.00	5	15.63	12	37.50
d	12	37.50	11	34.38	0	0.00	1	3.13	1	3.13	1	3.13	1	3.13

The family sector presents a similar pattern. It is found as a b-type space in a single graph (*Ta*), and it is included in at least one ring in the remaining cases: as a c-type, in five graphs and fifteen dwellings, and as a d-type, also in five graphs, but in eleven houses. This pattern contrasts with the isolation of the secondary family sector (f1). This sector is found in six graphs, always as an a-type space. The constitution of a private domain for the members of the family is the first sign of a new form of family structure in which individuals begin to construct their own spatial isolation.

The service sector is also found in three different space-types, but presents the most consistent occurrence amongst the main sectors. It is mostly found as a c-type space (eight graphs corresponding to 75.00% of the houses), followed by two graphs as an a-type space (*Ta* and *Tk*) and one graph as a d-type space (*Tj*). Therefore, the main purpose of the service sector is to maximise depth.

The multiplication of service sectors in the colonial houses is substituted by a concentration of the service rooms in a continuous set of spaces at the rear end of the house. This was an immediate consequence of the abolition of slavery and the introduction of the housemaids. The concentration the service spaces aimed at simplifying the domestic tasks, but also isolated the housemaid from the family hearth.

The mediator space is also present in three different forms, predominantly as a c-type space (three graphs and five dwellings), but also as a b-type space (two graphs) and d-type space (one graph). The majority of cases confirms that the mediator sector has the function of maximising depth and isolating the secondary family sector from the rest of the house.

Finally, the public space is found in three situations. As an a-type space, in five graphs, which corresponds to a majority of nineteen dwellings (59.58% of the sample). It is also found as a c-type in five graphs and as a d-type in graph *Tl*. In this rare occasion (house E31), the exterior gives independent access to the visitors', service. and family sectors.

5.2.3.3.1. Space-type profiles

The degree of space-ness represents the relative percentage of the occurrence of space types in each graph. The inequalities between the space-ness values generate typical profiles which describes the typical space-type composition of the graphs (figure 5.36. and table 5.12).

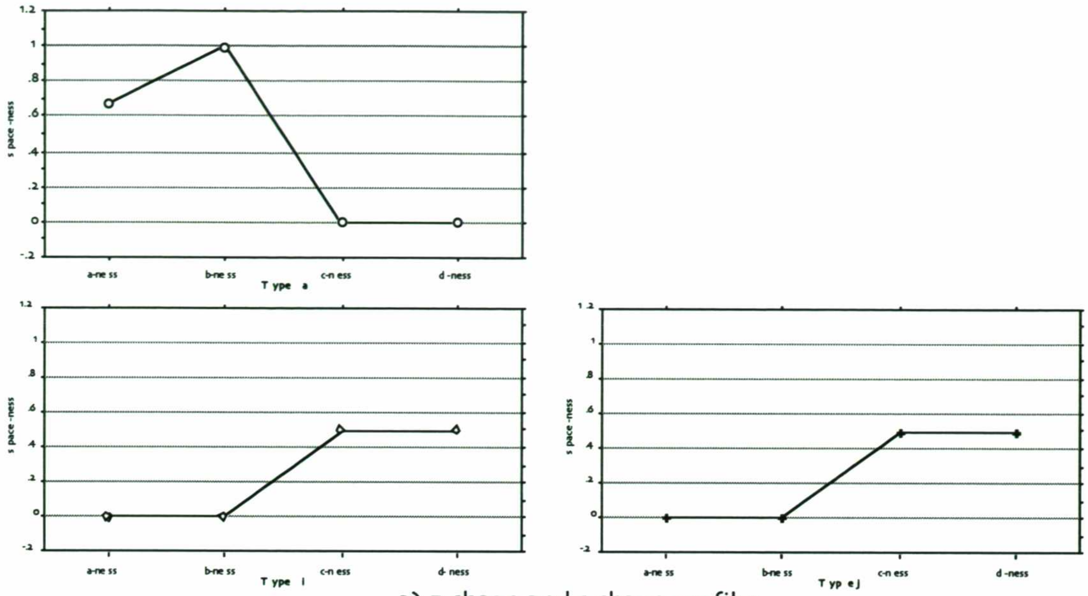
Table 5.12. The eclectic space type profiles

profile	types	inequality	graphs	houses	%sample	MDV
v-shape	Tk/Tl/To/Tp	a>b<c≤d	4	6	18.75	1.79
s-shape	Ti/Tj	a=b<c=d	2	6	18.75	2.00
sinusoid	Tb/Tc/Tm/Tn	a≥b<c>d	4	14	43.75	2.57
z-shape	Ta	a<b>c=d	1	6	18.75	2.40

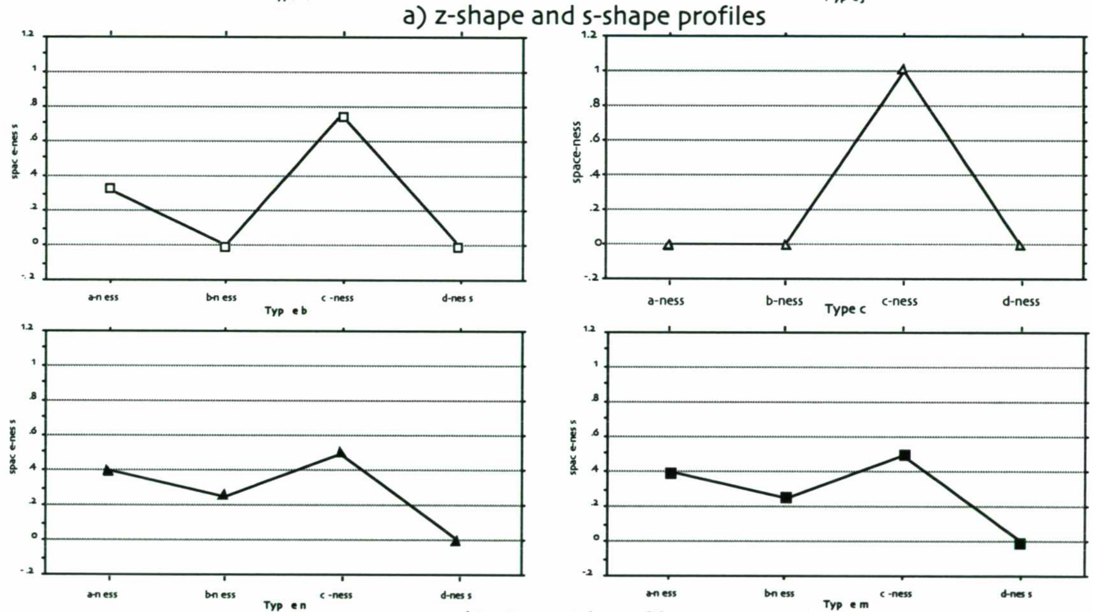
Two profiles are the most cited amongst the graphs. The first, is the 'sinusoid profile', present in graphs *Tb*, *Tc*, *Tm* and *Tn*, and in fourteen dwellings. These are on average the most differentiated graphs, with a DV of 2.57. This profile is widely spread amongst the sample, but it is predominantly found amongst middle-class-detached dwellings. The second is the 'v-shape' profile, also found in four graphs (*Tk*, *Tl*, *To* and *Tp*), but present in six dwellings. This profile is the least differentiated (MDV of 1.79) and it is unanimously found amongst upper-class-detached houses. The difference between the two profiles is the high degree of d-ness presented by the 'v-shape' profile. The predominant materialisation of this profile amongst upper-class dwellings indicates the higher complexity and degree of choice offered by wealthier dwellings.

The remaining profiles, 's-shape' and 'z-shape' are found in two and one graphs, respectively, and in six houses each. The 's-shape' profile is unanimously present amongst middle-class dwellings, mostly semi-detached. The z-shape profile is also predominantly middle-class, but more present in detached houses. Both profiles present high mean difference values (MDV), 2.00 and 2.40.

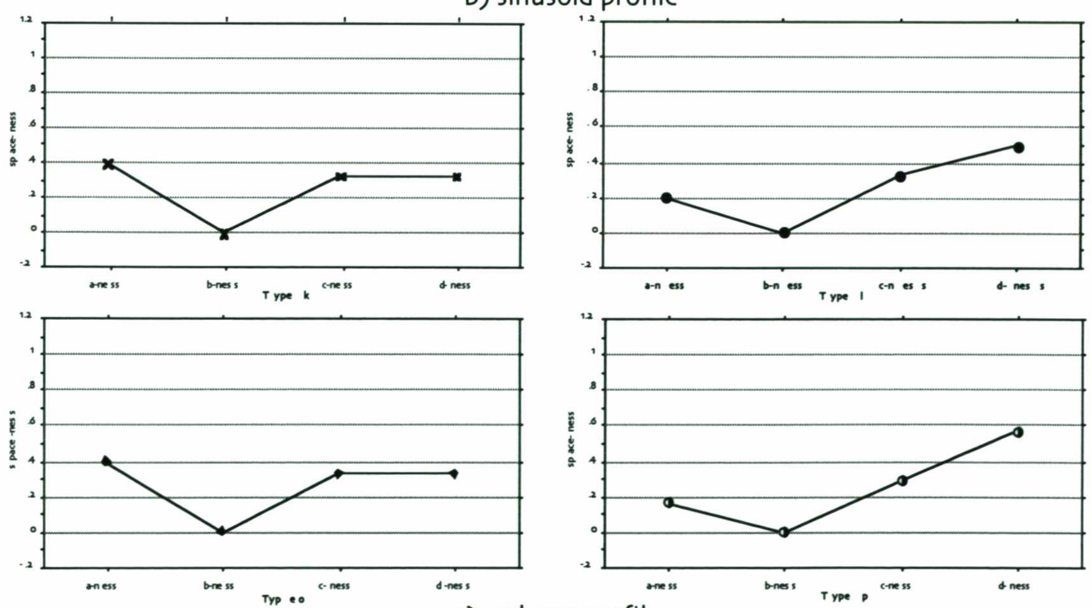
The average space-ness values for the sample (figure 5.37.), indicates the genotypical inequality for the eclectic dwellings. The inequality $b<d<a<c$ indicate a significant increase on the c- and d-ness values , when compared to the colonial sample. The graphs are significantly less tree-like and the number of rings are quite considerable. This surely indicates a transition to the ringy modern graphs.



a) z-shape and s-shape profiles



b) sinusoid profile



c) v-shape profile

Figure 5.36. The eclectic space-ness profiles

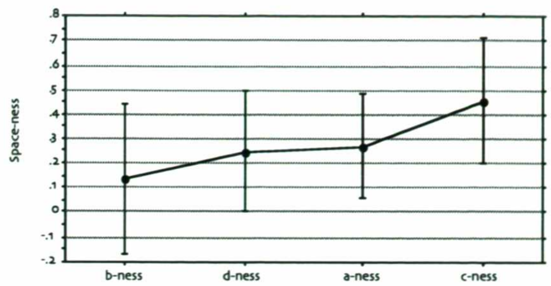


Figure 5.37. The genotypical eclectic space-ness order

5.3.3.3. Depth analysis

Figure 5.38. plots sectors' depth from the exterior. The steady colonial pattern is now substituted by an uneven positioning of the service and family sectors. The service sector is found two steps from the street in six graphs (*Tb*, *Ti*, *Tk*, *Tm*, *Tn*, *To* and *Tp*), corresponding to nineteen dwellings. It is found one step from the exterior in three graphs (*Tc*, *Tj* and *Tl*), corresponding to six cases. The service sector is also found deeper, at depth three, in two graphs (*Ta* and *Tp*), found in seven cases.

The family sector swings between one (three graphs and seven dwellings) and two steps (eight graphs and twenty five houses) from the exterior. The few cases in which the family sector is directly connected from the street, demonstrates the exceptionally of the cases.

However, some interesting consistencies are seen. For example, the visitors' sector remains in the same position as in the colonial houses, one step away from the outside. It is always the way to the house, despite other entrances being provided. Another interesting steady pattern is offered by the mediator sector, always deep, at depth two and three, isolating the secondary family sector from the rest of the system. This direct relationship between the two sectors is represented by their symmetrical position in the graph.

A general picture of the eclectic sample is captured by the average depth value of each sector, which is presented in figure 5.39. The visitors' sector is the shallowest sector, followed by the family and the service ones, as seen in the colonial model. However, the introduction of the mediator and the secondary family sector, arranged deeper in the system, characterises the transitionality of the eclectic dwellings towards a modern way of living.

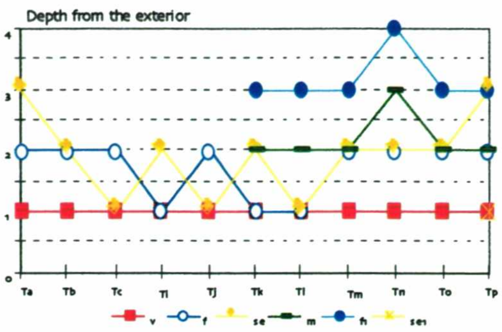


Figure 5.38. Eclectic sectors' depth

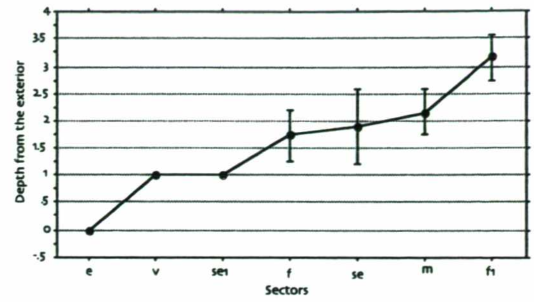


Figure 5.39. Eclectic sectors' depth

5.3.3.4. Integration analysis

Table 5.13. presents the rank order of integration of the sectors. The rank order of the of the main functional sectors is plotted in figure 5.40 and table 5.14. identify the genotypical inequalities in the sample.

Table 5.13. The eclectic rank order of integration (RRA)

Rank Order of RRA - All sectors							
	v	f	se	e			
Ta	0.999	=0.999	< 2.999	=2.999			
	v	f	se	e			
Tb	0.000	<0.999	= 0.999	<1.999			
	v	f	se	e			
Tc	0.999	=0.999	= 0.999	=0.999			
	v	f	se	e			
Ti	0.000	=0.000	< 0.999	=0.999			
	v	se	f	e			
Tj	0.000	=0.000	< 0.999	=0.999			
	f	v	m	e	se	f1	
Tk	0.287	<0.573	= 0.573	<1.146	<1.433	<1.719	
	f	v	m	e	se	f1	
Tl	0.287	<0.573	= 0.573	<0.860	<1.146	<1.719	
	v	m	se	f	e	f1	
Tm	0.287	<0.860	< 1.146	=1.146	<1.433	<2.005	
	f	v	se	m	e	f1	
Tn	0.573	<0.860	< 1.146	=1.146	<2.005	<2.292	
	v	f	m	se	e	f1	
To	0.287	<0.573	= 0.573	<1.146	<1.433	<1.719	
	m	v	f	se1	se	e	f1
Tp	0.196	<0.393	< 0.589	=0.589	<0.981	<1.178	=1.178

Rank Order of RRA - Main sectors						
	v	f	se	dv	case	%
Ta	0.999	=0.999	<2.999	1.20	6	18.75
	v	f	se			
Tb	0.000	<0.999	=0.999	1.50	7	21.88
	v	f	se			
Tc	0.999	=0.999	=0.999	0.00	4	12.50
	v	f	se			
Ti	0.000	=0.000	<0.999	3.00	5	15.63
	v	se	f			
Tj	0.000	=0.000	<0.999	3.00	1	3.13
	f	v	se			
Tk	0.287	<0.573	<1.433	1.50	1	3.13
	f	v	se			
Tl	0.287	<0.573	<1.146	1.29	1	3.13
	v	f	se			
Tm	0.287	<1.146	=1.146	1.00	1	3.13
	f	v	se			
Tn	0.573	<0.860	<1.146	0.67	2	6.25
	v	f	se			
To	0.287	<0.573	<1.146	1.29	3	9.38
	v	f	se			
Tp	0.393	<0.589	<0.981	0.90	1	3.13

Table 5.14. The eclectic sectors' genotypes

Ga - v=f<se					**Gc - v<f=se**					**Gd - v=f=se**				
	MRRA	DV	cases	%		MRRA	DV	cases	%		MRRA	DV	cases	%
Ta	1.999	1.20	6	18.75	**Tb**	0.999	1.50	7	21.88	**Tc**	0.999	0.00	4	12.50
Ti	0.500	3.00	5	15.63	**Tm**	1.146	1.00	1	3.13					
Mean	1.250	2.10				1.073	1.25				0.999	0.00		
Total			11	34.38				8	25.00				4	12.50
Ge - f<v<se					**Gb - v<f<se**					**Gf - v=se<f**				
	MRRA	DV	cases	%		MRRA	DV	cases	%		MRRA	DV	cases	%
Tk	0.955	1.50	1	3.13	**To**	0.955	1.29	3	9.38	**Tj**	0.500	3.00	1	3.13
Tl	0.768	1.29	1	3.13	**Tp**	0.729	0.38	1	3.13					
Tn	1.337	1.34	2	6.25										
Mean	1.020	1.38				0.842	0.84				0.500	3.00		
Total			4	12.50				4	12.50				1	3.13

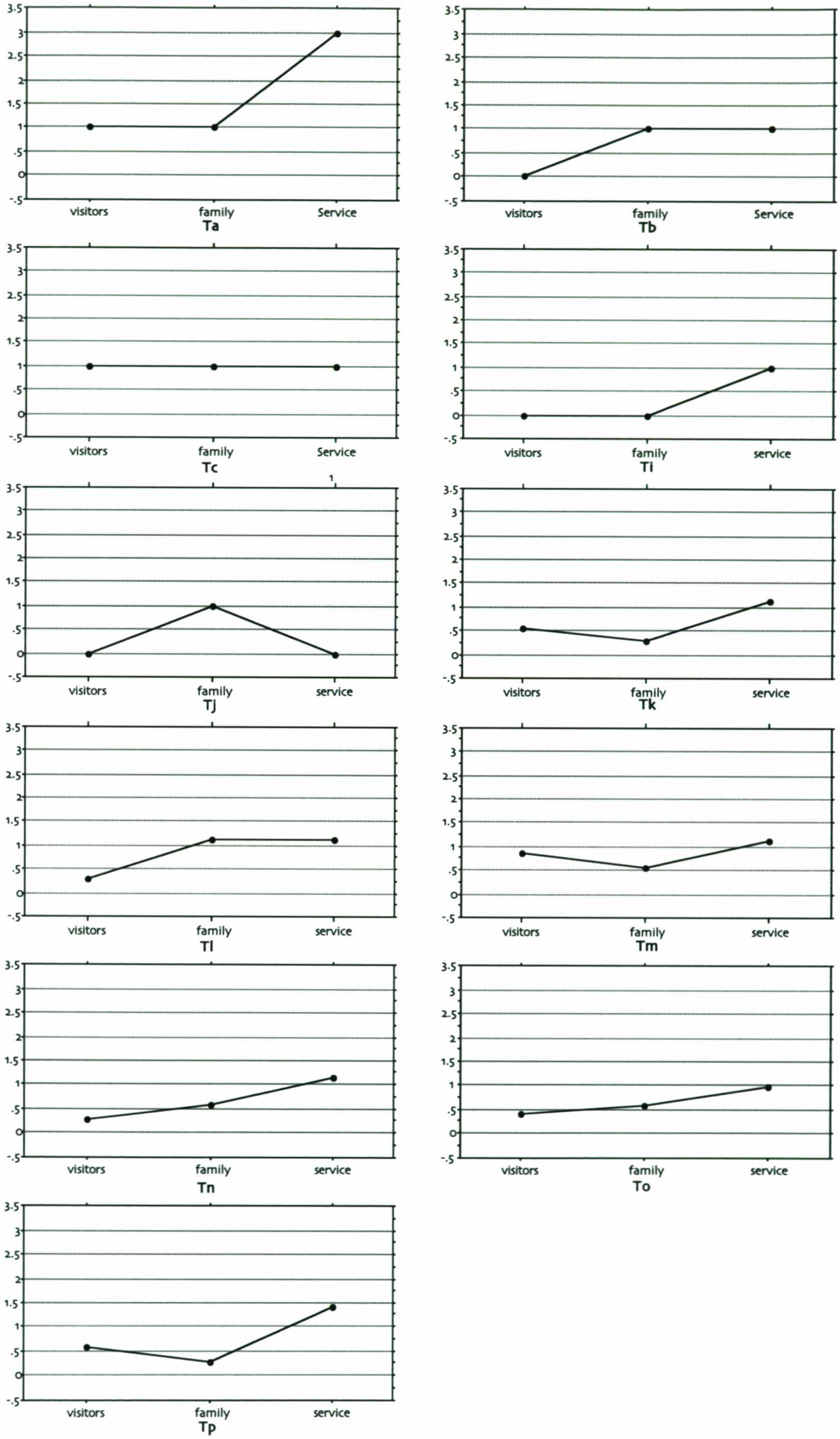


Figure 5.40. The rank order of integration of the main sectors

The high ranks of integration (low values) are mostly occupied by the visitors' and family sectors, whereas the low ranks (high values) are occupied by the exterior and the secondary family sector. The mediator space occupies the middle ranges of integration, but it is the most integrated space of type *Tp*.

The isolation of the main sectors shows six different inequalities in the order of integration (table 5.14.). Two are of more significance for its number of occurrences in the sample. All the colonial genotypes are also present in the eclectic dwellings, but a sixth inequality is introduced ($v=se<f$). Its exceptional case is expressed in its single occurrence in the sample (House E13), but mostly by its high degree of integration (0.500) and differentiation (3.00).

Genotype *a* ($v=f<se$) is, as in the colonial sample, the most cited amongst eclectic houses, found in eleven dwellings. It has the lowest MRRA (1.250) and it is highly differentiated (2.10). It is represented by graphs *Ta* and *Tl*, which are mostly found amongst ground-floor-middle-class-semi-detached houses.

Genotype *c* ($v<f=se$)is the second most popular amidst the sample (eight cases), and it is found in graphs *Tb* and *Tm*. It is more integrated (MRRA of 1.073) but less differentiated (MDV of 1.25) than genotype *a*. Genotype *c* was poorly cited amongst colonial dwellings and the significance of its occurrence amongst the eclectic dwellings is due to the access from the visitors' sector to the service sector through the outdoor spaces. They are mostly found amongst ground-floor-middle-class-detached houses.

The remaining genotypes are less popular. Genotypes *d* ($v=f=se$), *e* ($f<v<se$) and *b* ($v<f<se$), are found in four dwellings each. They are on average more integrated than the most popular genotypes and also more differentiated, apart form genotype *e* (DV of 1.38)

Figure 5.41. describes the average integration value for each sector and plots them in order of integration. The genotypical order indicates the higher values for the visitors' sector, followed by followed by the family and service ones. This ordering may be considered the basic eclectic sectors' model, from which the genotypes identified above are derived.

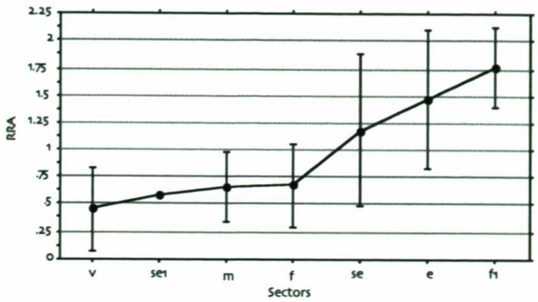


Figure 5.41. Colonial houses: overall genotype

5.3.3.5 The restrictive rules

What are the general rules that defined the sectors' arrangements of the eclectic dwellings? Are they similar to the colonial dwellings or are there new elements that express the transitionality between the patriarchal mode of behaviour and modern family life? The eclectic dwellings confirm a general rule which is applicable to the colonial, eclectic and modern samples. Size and complexity of the graphs are directly related to size and complexity of the houses themselves, and the wealth of their owners. The more simple a house is, the less requirements to attend, the more activities may be developed in the same space, and the less need to isolate territories in the household. More sophisticated houses would perform conversely.

Other rules keep some colonial taste. For example, the visitors' sector should be the shallowest and the most integrated of all, and be included in rings, either as a c- or d-type space. This indicates that the visitors' sector is responsible for distributing movement, but also, as a c-type space, to maximise depth in the system, while isolating the family and service sectors. The family sector should follow the visitors' one in order of integration and in depth from the exterior. Differently from the colonial family sector, the eclectic one should be included in rings, either maximising depth, as a c-type space, or generating movement, as a d-type space.

The service spaces, now united in a single sector, should form the most segregated of all main sectors, and be deeply positioned from the street. It should be included in a ring, therefore allowing free access of servants to different parts of the household

Other rules are more related to the modern times. For example, private places represented by the secondary family sector, and public places, represented by the exterior, should be the most segregated realms situated at the opposite ends of the graphs. Both territories are mostly found as a-type nodes, but the exterior is also included in rings, while offering different entrances to the house. The mediator sector should be positioned deep in the system, between the individual private spaces and the rest of the household, and occupy a b- or c-type position. This justifies its role as a depth maximiser.

In summary, the functional organisation of the eclectic dwellings follow some consistent requirements. The visitors' sector has to be placed in a shallow position, forming rings both with the family and service sectors, and occasionally with the public space. The family sector has to be deeply situated, but central in the configuration. The service sector has to be segregated, but easily accessible from the remaining sectors. Higher degree of privacy has to be achieved by creating a more secluded zone for inhabitants use, further isolated with the introduction of mediator spaces. Finally, as a general rule also common to the colonial houses, the more sophisticated housing program gets, the more complex the sectors' arrangement is.

5.4. The social paradigm

Lúcio Costa argues that the Brazilian house originates from the symbioses of Portuguese, Native Indians and African traditions and sustains a simple but powerful interpretation of the evolution of the Brazilian dwelling (Costa, 1995). He suggests that the Native Indians influenced the form of Brazilian dwellings *only* in the layout of the first shelters built by the colonisers. The *feitorias'* layout consisted of a single space, very much similar to the aborigine's *oca*, covered by a single and low tiled roof.[33] This temporary accomodation was later enclosed to gain protection from the elements, but terraces at the opposite sides of the building were created, one for living and the other for working. With the establishment of Portuguese colonisers in the Brazilian territory, the layout became more and more complex to accommodate social and individual requirements. However, the polarity front-formal/back-informal remained.

The evaluation of how domestic activities are distributed in dwellings' layouts confirmed much of Costa's speculations. Indeed, the front-formal/back-informal polarity was present in all types of Recife's dwellings, albeit assuming different forms. The colonial houses, both *casas térreas* and *sobrados*, present clear functional territories in their layouts, but the formal/informal poles are manifested differently. In the casas térreas the polarity is horizontally structured (front and back), whereas in the *sobrados* it is vertically organised.

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33 The first Brazilian house was also the object of Freyre's studies: '*There have been many discussions as to which was the first European type of house built in Brazil. There are those who suppose it to have been the Carioca house. It is believed that in 1504 Gonçalo Coelho built a house beside a brook, perhaps in a small settlement, to which the native gave the name of "white man's house*' (Freyre, 1963: 136).

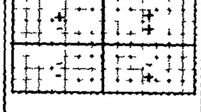
The eclectic dwellings reinforced this horizontal polarity by formalising a single service territory at the rear end of the household, which is intrinsically related to the family realm, located at the centre of the sectors' model. The vertical polarity of the colonial model provides in the eclectic house another kind of inequality, this time between individual privacy and family community, which later pervaded the modern houses.

The establishment of functional territories in Recife's domestic environment is therefore a long lasting cultural tradition. This confirms the thesis that the strong form of functional sectoring of Recife's modern dwellings is an expression of cultural continuity, as well as a consequence of the formal education of the modern architect. It seems that these two natures, one socio-cultural, and the other methodological, formed the basis of the sector' paradigm. The social face of it established the acceptance of the methodological design procedure, because made clear or conscious the topological model, or gene, of houses' functional structure. The methodological face strengthened this traditional form of assigning similar functions to continuous sets of spaces.

The social face is responsible for defining certain kinds of continuities, but also of significant changes. The clear delimitation of the service sector(s) in the colonial, eclectic and modern houses, is an evident sign of a consistent diachronic phenomena. A significant change is expressed by the constitution of a private sector in modern houses, but also in some eclectic dwellings, giving place for individual spaces.

The recognition of the sectoring nature of the historic houses of Recife also highlights the fact that vernacular buildings may also be structured into functional sectors, and therefore, they should be analysed likewise. Hence, the sectors' analysis should be established as an essential phase in the syntactic analysis of purposeful buildings in order to describe their 'topological gene'. After all, if buildings are indeed classifying devices, as suggested by Markus (1987; 1993) instruments that societies use to 'define and reproduce social structures, and to elaborate the meaning of relationships' (Markus, 1987: 468), then one form of identifying how these devices work is by observing the nature of their sectors.

In summary, this chapter has proven that sectoring is part of the local housing tradition. It has demonstrated how these functional sectors are manifested in houses' layout. More importantly, it showed the general rules which have guided the definition of such territories. Both colonial and eclectic dwellings were proven to be structured in defined sectors, but each one was arranged in particular manners, as described in the analysis. The next chapter investigates the nature of these differences, and also similarities, in a broader comparative analysis of historical and modern samples.



Chapter Six
Pre-modern and Modern Houses Reviewed

The previous chapters proved that the houses of Recife categorise and group similar domestic activities and users into spatio-functional sectors, but in different forms. This chapter makes a comparative analysis of the sectors' structure of pre-modern and modern houses in two stages. Firstly, in section 6.1., the results of the sectors' analysis for the colonial, eclectic and modern samples are compared, observing their average geometrical and syntactic data. Secondly, the comparative analysis considers the description of the composition of the sectors themselves, accounting for their internal structures, if tree-like or ringy, and the nature of their boundaries, if closed or opened. Section 6.2. presents the methodological procedure used in this analysis, which is then applied in a sub-sample of pre-modern and modern houses in section 6.3. Finally, section 6.4. presents some concluding remarks on the evolution of the spatial organisation of the houses of Recife, based on the transformations of their sectors' structures.

6.1. The sectors' paradigms: the social versus the spatial

The first part of this comparative analysis looks at how the houses were functionally organised. It compares the structure of the sectors' graphs and identifies the changes in their configuration through time. Table 6.1. shows the average values of the main geometrical and syntactic data for the pre-modern and modern samples. The average space-ness and integration values are calculated on the basis of the number of sectors' graphs, and not on the number of occurrences of these graphs in the sample; therefore it counts only the properties of the sectors' diagrams themselves.

Table 6.1. Pre-modern and modern houses: the comparative data

Sample	**Area**		**Convex**		**Ratio**	**Graphs' size**		
	plot	house	all	inside	g:h	min	mean	max
colonial	215.07	210.93	22.29	18.21	1g:1.75h	4	5.13	7
eclectic	593.85	234.69	32.23	22.15	1g: 2.90h	4	5.13	7
modern	666.49	286.34	36.48	22.69	1g:6h	4	5.91	8
	Integration (RRA)							
	min	mean	max	DF	DV	genotype	%	
colonial	0.860	1.238	1.999	0.85	0.83	v=f<se	49.99	
eclectic	0.500	0.990	1.999	0.65	1.29	v=f<se	34.38	
modern	0.499	0.948	1.337	0.82	0.90	s=se<p	53.43	
	Space-ness							
	a-ness	b-ness	c-ness	d-ness	DV	genotype		
colonial	0.47	0.34	0.30	0.12	1.14	d<c<b<a		
eclectic	0.27	0.14	0.46	0.25	1.14	b<d<a<c		
modern	0.23	0.03	0.50	0.29	1.79	b<a<d<c		

6.1.1. The graphs-house ratio

The first aspect that should be observed in this comparative analysis is the ratio between the number of diagrams and the number of houses in each sample. If this ratio represents a degree of experimentation, then the colonial sample is the most experimental of all, with a ratio of one graph for every 1.75 dwellings, immediately followed by the eclectic sample (1:2.90). The modern sample, on the other hand, shows the highest ratio, suggesting that the modern dwellings are more restricted to certain types of functional organisations.

These values, however, should be interpreted with caution. They are indicative rather than conclusive. The sheer difference of the size of the samples may have induced the graphs-houses ratio by stressing the variety of cases in the small sample of colonial dwellings and the repetition of typical functional arrangements of the modern houses. It is possible that some of the most cited colonial graphs could be extensively repeated if a larger sample were available, mainly if Vauthier's impressions of an endless repetition of typical layouts are considered to be true (Vauthier, 1975). Despite the statistical unreliability of the 'graphs-houses ratio', they do indicate that the modern sample is more restricted to certain types of functional arrangements, demonstrating the strength of the paradigm of sectors amongst modernist designers. This is confirmed by the outstanding popularity of certain sectors' arrangements. For example, types T2, T5, T7, T14 and T17 are found in 63.21% of the modernist sample (see table 3.1).

6.1.2. Syntactic and geometrical sizes

A diachronic comparison of the geometrical and syntactic sizes of the samples shows that, on average, Recife's residences became larger through time. The colonial sample present the lowest house and plot areas, and also the lowest number of convex spaces. This is due to the limitations of land, and therefore its high costs, during the first centuries of urban development in Recife.

The expansion of Recife's urban fabric from the original insular settlement towards the mainland, as described in chapter four, is reflected in the significant increase in the average dimension of the eclectic dwellings. This is particularly evident in the area of their plots, which are on average double the size of the colonial sites (593.85m^2 against 215.07m^2). Modern houses confirm this trend by presenting the larger houses of the samples, both in area and number of convex spaces (table 6.1.).

However, in spite of this tendency of designing larger houses in more recent periods, the average number of convex spaces of the houses themselves did not increase significantly. The average value for the colonial houses is 18.21, whereas for the modern houses it is 22.69. Bearing in mind that in the colonial houses each functional space corresponded to a convex unit, this slight increase of convexiality indicates how conventional most of the modern houses are. Indeed, the idealised open plan was rarely seen in modernist Recife residences. In this regard, the open plan was mostly explored in the configuration of their social areas, in which the flow of space through the living, dining and receiving spaces was very much appreciated.

The modern houses are not only more susceptible to certain kinds of sectors' organisations, as shown in section 6.1.1., and more convexialy articulated, but they are also more complex, sectorwise, than the pre-modern houses (table 6.2.). The majority of modern graphs have seven nodes (32.35%), whereas the colonial dwellings are mostly organised in simple four-element graphs (37.50%) and the eclectic dwellings are equally found as four and six-element graphs (45.45% each). The complexity of modern dwellings is also expressed by the number of houses organised in more complex sectors' systems. For example, 57.14% of the colonial and 71.87% of the eclectic houses are organised as four-element diagrams, whereas 53.43% of the modern houses are organised as five element diagrams.

The fundamental difference between the pre-modern and modern ways of sectoring the houses is the general use of mediator sectors in order to assure a more stable functional organisation, by establishing a higher degree of control and isolation of the different domestic territories. This aspect is reinforced by the tendency in generating secondary sectors to attend to specific functional requirements, as discussed in chapter 3. These characteristics picture the modernist houses as functionally more complex and precise in establishing a consistent relation between function and space.

Table 6.2. The sample by the size of the graphs

Sample	**Size**									
	4		5		6		7		8	
	n° graphs	% total	n° graphs	% total	n° graphs	% total	n° graphs	% total	n° graphs	% total
colonial	3	37.50	2	25.00	2	25.00	1	12.50	0	0.00
eclectic	5	45.45	0	0.00	5	45.45	1	9.09	0	0.00
modern	3	8.82	10	29.41	9	26.27	11	32.35	1	2.94
	n° houses	% total	n° houses	% total	n° houses	% total	n° houses	% total	n° houses	% total
colonial	8	57.14	3	21.42	2	14.28	1	7.14	0	0.00
eclectic	23	71.87	0	0.00	8	25.00	1	3.13	0	0.00
modern	33	16.18	109	53.43	46	22.54	15	7.35	1	0.49

Despite the differences in the size of the sectors' graphs, the samples confirm that their size is a good indicative of the functional and spatial complexity of the houses, and the social status of their owners as well. The samples confirm the general rule which says that the more sophisticated and larger (both topologically and geometrically) a house is, more complex the arrangement of the sectors will be. Indeed, the highest ranks of society require more specificity while assigning functions to space, preferring to create precise territories to develop certain kinds of activities and to further isolate household members. On the other hand, simpler houses tend to explore the polifunctional nature of space, by assigning different, and sometimes contrasting, activities for the same space. Hence, the general rule can be reformulated to express that the simpler a house is, the more polifunctionally conceived it would tend to be, and the more complex a house is, the more functionally determined it would tend to be.

6.1.3. Space-ness values

But the most significant difference between the forms by which historic and modern houses are sectored is expressed by their space-ness, depth and integration values. The genotypical space-ness inequalities of the samples indicate that Recife's domestic functional structure evolved from a tree-like or asymmetric model, with high a- and b-ness values, to slowly assume the form of a ringy or symmetric model, with high c- and d-ness values (see table 6.1.).

The tree-like model is found in the colonial sample. It presents the lowest c- and d-ness values, and the highest a- and b-ness values, which are, in fact, the extreme space-ness values of the three samples. They are also the lowest differentiated dwellings, with a DV of 1.14, just above the low-high level of differentiation (1.00).

The eclectic dwellings make the transition from the colonial tree-like model to the modern ringy system. Their rank order of space-ness, $b<d<a<c$, expresses the significant decrease in their b-ness values and the increase in their average c-ness values. There are more choices for accessing the house from the street, but also more choices to move about the system. However, despite the relaxation of the strict colonial model, the low d-ness value of the eclectic sectors' graphs indicates how economical they are in offering optional routes of movement. In spite of these changes in the composition of the sectors' graphs, the eclectic diagrams remain poorly differentiated (DV of 1.14), which means that the colonial and eclectic sectors' graphs use similar 'amounts' of space-types. In other words, both sets of graphs are on average composed of

similar degrees of space-types, expressing in each case, an interesting variety of types. The less differentiated the graphs are, the more similar they are, in the sense that they would tend to present the same proportional amounts of space-types. Variety in this case means undifferentiation, whereas unity means high differentiation.

The modernist sample establishes a new domestic model, which is exactly the opposite of the colonial model. The rank order of space-ness, *b<a<d<c*, is the sheer expression of a substantial transformation of the domestic functional organisation. It fixes the concept of a ringy and more dynamic domestic configuration, in which the transition between houses' sectors is often done by different possible routes. The evidences of this complete transformation of the diagrammatic organisation of the houses is also expressed by the higher degree of differentiation of the topological composition of the modern graphs. The difference value for the modern sample is 1.79, the highest of all, a consequence of the low and almost inexpressive b-ness value (0.03). This high differentiation is an indication of a more homogeneous set of graphs, in which the use of rings as the ideal mode of structuring the houses establishes a more uniform composition.

6.1.4. Depth pattern

The evolutionary changes of Recife's houses is also expressed in the average number of steps from the public space to each sector (table 6.3.). Considering the main domestic sectors - visitors', family, service, social, private and mediator, the depth pattern reveals a curious phenomenon.

Table 6.3. Mean depth of Recife's domestic sectors

Sample	**Sectors**														
	v	s	s1	p	f	f1	se	se1	se2	st	e	m	m1	em	m
colonial	1.00				2.00	2.00	2.63	1.80	2.00	1.00	0.00				
eclectic	1.00				1.73	3.17	1.91	1.00			0.00	2.17			
modern		1.35	3.00	2.97			1.44	4.00			0.00	2.25	2.25	1.00	

v=visitors'; s=social; p=private; f=family; se=service; st=store; m=mediator; em=external mediator

Firstly, the service sector, the only sector to keep its fundamental characteristic intact through time, despite being initially occupied by slaves and later by domestic servants, becomes significantly shallower. The colonial service zone has a mean depth of 2.63, which is reduced to 1.91 in the eclectic houses, to be positioned finally at 1.44 steps from the exterior in the modern houses. This change is quite significant. It describes how slaves and service spaces, once dispersed in different parts of the colonial house in order to praise the immediate needs of the family had, with the abolition of slavery, to be concentrated in a single and isolated area to isolate the housemaids and simplify their duties. This is why the service units needed to be positioned closer to the street, allowing for an independent access of the servants, establishing the social inequalities present in the household at its very boundaries. This more operative and socially discriminative organisation was sketched in the eclectic plan, but particularly refined in the modern houses.

Secondly, the spaces for receiving guests, initially grouped in the pre-modern visitors' sector and later in the modern social sector, are the shallowest of all main sectors in every sample. Curiously, contrarily to the service sector, the mean depth of the 'guests' sectors' increased diachronically. This is due to the introduction of external mediators in the modern houses, which respond to the need to generate a buffer or transitional zone between public and semi-private spaces and to concentrate social and service accesses in a single convex space, facilitating surveillance and control. Thirdly, the spaces for individual use, isolated first in the eclectic secondary family sector and later in the modern private sector, become shallower (3.17 to 2.97) with time, but remained as the deepest sector of all. Finally, the mediator sector becomes deeper in the system, but the difference between the position of the eclectic and the modern mediator sectors is negligible. In fact, in both samples the mediator sector is either two or three steps from the street; consequently it may be said that this sector has not changed considerably through time, maintaining its fundamental role as a buffer zone and its relative position stable.

6.1.5. Integration pattern

If the topological composition of the graphs changed dramatically, some of their configurational properties remained intact. The genotypical order of integration of the sectors, $v=f<se$ (Ga), was kept quite constant through time (see table 6.1.). Colonial and eclectic dwellings are predominantly organised to place the visitors' and family sectors at their configurational centre, and to segregate the service sector. This genotype is present in 49.99% of the colonial and in 34.38% of the eclectic houses. The modern sectors' genotype, $s=se<p$, present in 53.43% of the houses, is curiously similar to the pre-modern genotype, $v=f<se$, not only in its form, but also in what it represents.

Despite being submitted to the same genotypical order of integration, colonial and eclectic sectors graphs present substantial differences. Eclectic graphs are more integrated and more differentiated than the colonial sectors' graphs, resulting from the shallowness or ringiness of the eclectic arrangements.[34] Indeed, eclectic houses are less restrictive, building up spatial systems which offer a higher degree of choice in moving from one domestic territory to the others, and from the public spaces to the house itself.

This relaxation in the sectors' diagrams may be interpreted from two points of view. Firstly, as a consequence of the simple enlargement of the plots, therefore allowing for direct access from the front-formal-visitors' area to the back-informal-service zone. Secondly, it may also be understood as a step towards a more relaxed way of living, in which the desire to protect the privacy of the family is transposed to the spatial isolation of their individual members, materialised in the modern house.

The mean integration values for the samples picture this process. The colonial dwellings present the most segregated diagrams, with an average value of 1.238. The eclectic dwellings reduces drastically the RRA values to 0.990. Modern houses present the most integrated set of diagrams, with a mean RRA value of 0.948.

The pre-modern visitors' sector and the modern social sector have many aspects in common. They are both the most integrated and the shallowest sectors in both types of houses, and they were primarily conceived to house formal ceremonies and to represent the wealth and the beliefs of the household members. Their similar positions in the rank order of integration highlights the fact that receiving remained at the centre of the diagrammatic concept of the houses of Recife. In reality, the modern social sector is the amalgamation of the pre-modern visitors' sector and the spaces of the family sector for communal use. Therefore, the centrality of the social sector corresponds to this long lasting traditional form of diagrammatic organisation. With this readjustment of the sectors' arrangement of the modern house, and more significantly with the creation of the private sector, the service node becomes more integrated, than in the historic houses. Its operative nature is reinforced at the same time as the isolation of the private sector is reinforced.

It is important to highlight that more choices of movement offered by the modern houses does not necessarily mean that they are less restricted to the access of strangers to all compartments of the house. The use of buffer zones in form of mediator spaces is a clear sign that isolation and control are still necessary to give a certain kind of 'domesticity' to the buildings themselves.

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34 The differentiation amongst the RRA values are expressed in table 6.1. in difference factor (DF) and difference value (DV). The use of both procedures is justifiable to help the reader used to the difference factor in visualising the figures presented by the difference values.

But it is exactly the use of mediator spaces that informs in what way isolation and control are differentially handled in pre-modern and modern dwellings.

Table 6.4. Mean integration of Recife's domestic sectors

Sample	**Sectors**													
	v	s	s1	p	f	f1	se	se1	se2	st	e	m	m1	em
colonial	0.595				0.843	0.785	1.801	1.268	1.177	1.003	1.637			
eclectic	0.452				0.677	1.772	1.181	0.589			1.459	0.653		
modern		0.517	1.307	1.456			0.685	1.305			1.384	0.665	0.817	0.719

v=visitors'; s=social; p=private; f=family; se=service; st=store; m=mediator; em=external mediator

Differences in the degree of integration of the sectors through time reveal how the transformation from a segregated to an integrated system occurred. This is demonstrable in the mean integration values of the service sector, for example. It departed from being the most segregated unit of all in colonial times, to assume one of the most integrated positions in the modern model. The operative or functional nature of the modern house urged for a more integrated set of service spaces, closer to the complex as a whole, delivering the necessary support for the maintenance of dwellings' daily life, as already discussed in the previous section.

The same increase in the integration pattern is revealed by the public node. The public space is kept apart from the household throughout history, being always amongst the most segregated nodes of the graphs. However, the significant decrease on its mean integration value, from 1.637 to 1.384, demonstrates that modern dwellings became closer to the street. It seems that the colonial horror of the impurity of the urban life was replaced by a more complacent view of the street, while keeping the necessary limits between privacy and community.

The segregation of the public sector is only comparable with the private sector. The modernist private sector and the secondary family sector (f1) are respectively the most segregated nodes in modern and eclectic graphs. If the private spaces are traced through history, then the modern form of organisation, despite being solemnly retrieved from the social territories of the house, is more integrated than its eclectic counterpart. This is because the isolation of the bedrooms in the eclectic houses are only manifested in first-floor houses, in which the connection to the rest of the house is solely made through a mediator sector, whereas amongst ground-floor modern dwellings, and even first-floor dwellings, alternative accesses are guaranteed.

Finally, the visitors' and family sectors also have a significant increase in their mean integration value, corresponding to the ringiness of the eclectic sectors' graphs, in contrast to the tree-like colonial model. Curiously, the value for the modern social sector stays between the values for the visitors' and family sectors, perhaps denoting the amalgamation of the functions of both pre-modern sectors.

6.1.6. On the fundamental changes in Recife's domestic sectors

With these aspects in mind, the passage from the visitors-family centred model to the social-service centred model becomes obvious. In fact, they seem to express the natural evolution of Recife's society and domestic built form. A process which may be characterised as follows:

a. The spaces for communal use of the members of the family and the spaces for receiving and entertaining guests were initially isolated in different territories of the house, in order to sustain and reinforce the privacy of the family. This patriarchal model helped to sustain the unity of the family and the control of the patriarch over the other members of the household. In this sense, social codes of behaviour pervaded over the potential occupation of spaces, by restricting accesses and delimiting physical barriers between the sectors.

b. With the decay of the patriarchy and the establishment of a modern society, individuality and privacy became cherished as essential personal needs. The isolation of the spaces for the use of individual members of the family brought the first fundamental change in the sectors organisation of Recife's dwellings. The bedrooms were isolated in a deep and segregated part of the house, forming the modern private sector, already enunciated by the eclectic secondary family sector. Spaces for the communal use of the family were grouped under the social area, also used for receiving and entertaining guests. This was suppose to represent a modern attitude towards a more spontaneous and practical lifestyle, which substituted the later visitors' room, house of the treasures of the family, repository of their memories and the reliquary of their history, for a transparent showcase of what a modern and practical daily life should be.

c. The conflicting interests in isolating the spaces for individual use and opening the spaces for living and receiving guests generated the need to introduce buffer sectors. In this less controlled society, in which the codes of behaviour were more relaxed, space was used as a form to establish isolation between houses' territories by building up spatial depth, in substitution to both physical (doors and walls) and social barriers. The mediator space allowed for the much needed flow of space, but constructed 'virtual' or 'implied' boundaries between the sectors.

d. In summary, it may be said that the pre-modern domestic diagrams are primarily social manifestations controlled by social codes, whereas the modern diagrams are dominated by spatial considerations, with social codes a lesser issue, though still an important consideration. The first are reinforced by social codes of behaviour, whereas the second are constituted by subtle spatial moves. The first impose restrictions to the use of a flexible plan, whereas the second has already embedded in its layout the restrictions of space use.

This synopsis of the evolution of the functional organisation of the domestic buildings of Recife gives a general picture of the most fundamental changes in the form in which people occupied their houses. Indeed, the sectors organisation describes the fundamental layer in the spatial organisation of buildings, or what has been called, their 'topological genes'.

However clear this evolutionary process of classifying and grouping activities and users in defined territories of the dwellings may be, there are some other aspects that should be taken into account in this comparative analysis, in order to understand in more detail the sort of changes which have occurred in the functional organisation of the houses. For example, it has been described that the spaces for receiving guests suffered a substantial change, becoming more open and integrated to the other spaces of the houses. On the other hand, the isolation of the bedrooms in a secluded sector modified the previous layout of the houses, substituting the typical matrix-of-cells layout of the ground-floor eclectic dwellings, for example, for the modern corridor layout, as described in chapters five and three, respectively. These two cases exemplify the kind of differences in the houses which lie beyond the formation of a generic topological diagram for the organisation of the dwellings. It lies in the layout of the houses themselves and how the diverse sectors models influenced the generation of these plans. It is possible that some peculiarities in the composition of houses' layouts might have been kept stable in spite of the alterations in the way functions were grouped into orderly sectors. One might ask if the similarities and inequalities in the form by which houses were sectored may also reveal the way the sectors themselves are organised.

6.2. The structure of the sectors

One way to answer this question is by looking at each individual sector, and analyse their spatial configurations. For example, if they have high or low values of permeability; if users are supposed to move about these sectors either by following long sequences of spaces or by transiting through rings; if the sectors are enclosed or with limited access, or if they are opened to access and movement. The own nature of the sectors themselves can express many of the intentions, conscious or unconscious, of the designers and inhabitants. By strongly isolating different sectors, different categories of users will meet each other under some circumstances, possibly meticulously predicted. By highly integrating different sectors, different categories of users will be allowed to interact in a more informal basis.

The sequence of justified graphs in Figure 6.1. corresponds to a random selection of pre-modern and modern houses previously studied. The houses are not identified in order to produce a comparison without being biased by the previous analysis. The dwellings are represented in their 'minimal living complex', i.e., 'the least continuous interior set of spaces which linked together the main living spaces, plus whatever functions formed part of that complex' (Hillier, Hanson et al., 1987: 367). The graphs are drawn by taking the outside as a carrier space, thus reducing the complexity of the graphs. The sectors are coloured to differentiate themselves, however, without labelling the individual sectors as social, service, private, family or visitors'. The only distinction is made for the mediator sector and the carrier itself.

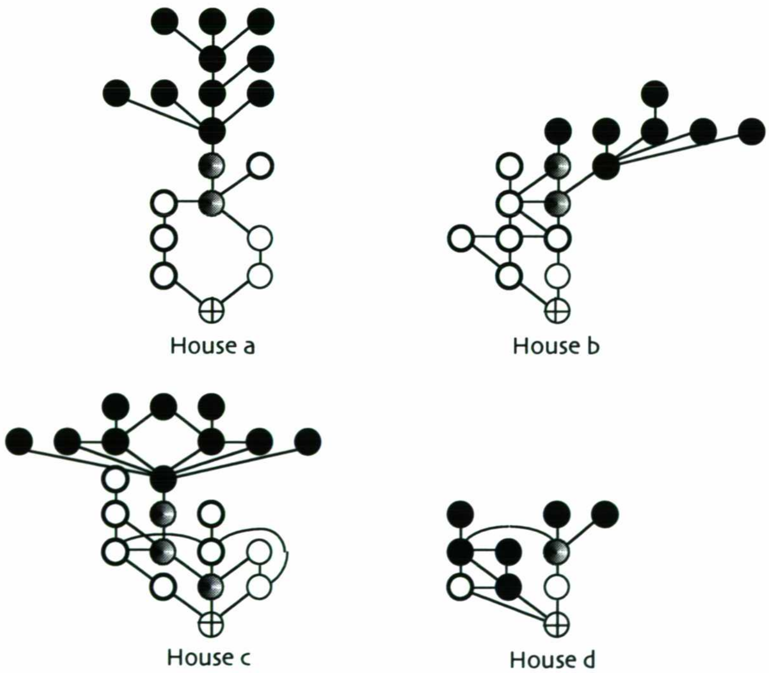


Figure 6.1. Justified graphs of a random selection of pre-modern and modern houses

6.2.1. Isolating the branches

Figure 6.2. shows each of the sectors isolated from their neighbours. A simple observation of these justified graphs suggest some interesting characteristics. Some graphs are either composed by a single element or by a vast percentage

of the total number of convex spaces of the house. Size, can be a sign of the complexity of the program, or a simple multiplication of standard rooms, like bedrooms.

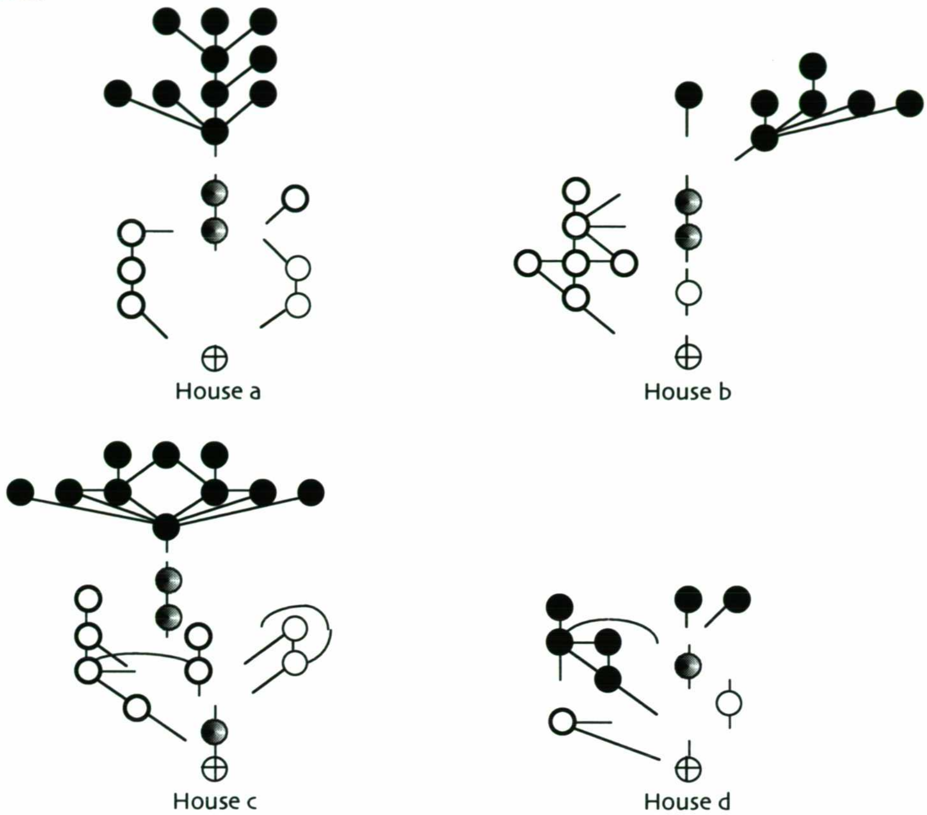


Figure 6.2. Justified graphs with the sectors isolated

Some sectors are constituted by long and deep sequences of spaces. Tree-like sub-systems, composed basically by a- and b- type spaces, appear either as deep structures (house a) or shallow bushes (houses a and b). Tree-like systems allows for high control of movement, which make more effective particular needs of domestic life, such as privacy and isolation, or introduces formality and symbolism to deep and controlled spaces, like the master bedroom. As Hanson has suggested, 'tree-like domestic space arrangements produce strongly programmed forms of domestic space arrangements' (Hanson, 1998: 278).

Other sectors offer choices of access and movement. Some are formed by a single ring (house d), others by multiple rings (houses b and c). The number of rings is important because it represents the degree of choice of movement in the system. Some rings are local and trivial (houses b and c), with no substantial effect in the overall configuration of the sector, and other rings involve the whole sector (house d).

Each one of these particular configurations can be represented by the degree of ringiness of each sub-system. The space-link ratio has been systematically used in space syntax studies to account for the degree of ringiness of a system, as applied for example in chapter two. There is, however, an intrinsic problem in the use of this measure. It does not allow a direct comparison between systems of different sizes, because when the maximum ringiness is achieved the bigger the system is, the higher the numerical value will be. This is proven by calculating the maximum space-link ratio for graphs with different sizes. For example, in a four space system the maximum value is 1.75, whereas in a six space system is 2.16, with seven is 2.28, and with eight is 2.37.

This distortion can be solved by using a more accurate measure previously proposed by Hillier and Hanson (1984). The 'relative ringiness' is 'the number of distinct rings over the maximum possible planar rings for that number of points: 2p - 5 where p is the number of points in the complex' (Hillier & Hanson, 1984, pp 154), which gives the equation,

$$RR = \frac{r}{2p-5} \qquad [9]$$

where RR is the value of relative ringiness; r the number of rings in the complex; and p its number of points or nodes in the graph. The RR values range from 1.00, maximum degree of ringiness, to 0.00, a tree.

However, as most of the space syntax computer programs (Dalton, 1990a; Dalton, 1996; Dalton, 1997) account for the number of connections and not for the number of rings in a given spatial complex, the previous equation has to be adapted to account for the number of connections of the graphs. The 'relative connectivity' (RC) is expressed by the equation,

$$RC = \frac{c-(p-1)}{2p-5} \qquad [10]$$

where RC stands for relative connectivity; c for the number of connections in the complex; and p for its number of points or nodes in the graphs. The RC values range from 0.00, a tree-like graph, to 1.00, the highest possible number of rings in the graph.

From this equation it is also possible to calculated the maximum number of connections in a system of a given number, if this is what is necessary to assess. The equation takes the following form:

$$MC = 3p-6 \qquad [11]$$

where MC stands for maximum connectiveness and p for the number of points or nodes in the graph.

6.2.2. Connecting the branches

As sub-systems of a bigger complex, the sectors are interconnected in order to make the whole complex work according to its utilitarian requirements. Some sectors, as highlighted in figure 6.3., are extremely isolated by having a single access to/from the rest of the system (houses a, b and c). This connection can either be seen at the end of a long sequence of spaces (house a) or at the configurational centre of the sector (houses b and c). The property of having a restricted and easily controlled access determine a clear identification of the sectors' boundaries. Crossing these 'clear boundaries' without allowance could be read as a transgression.

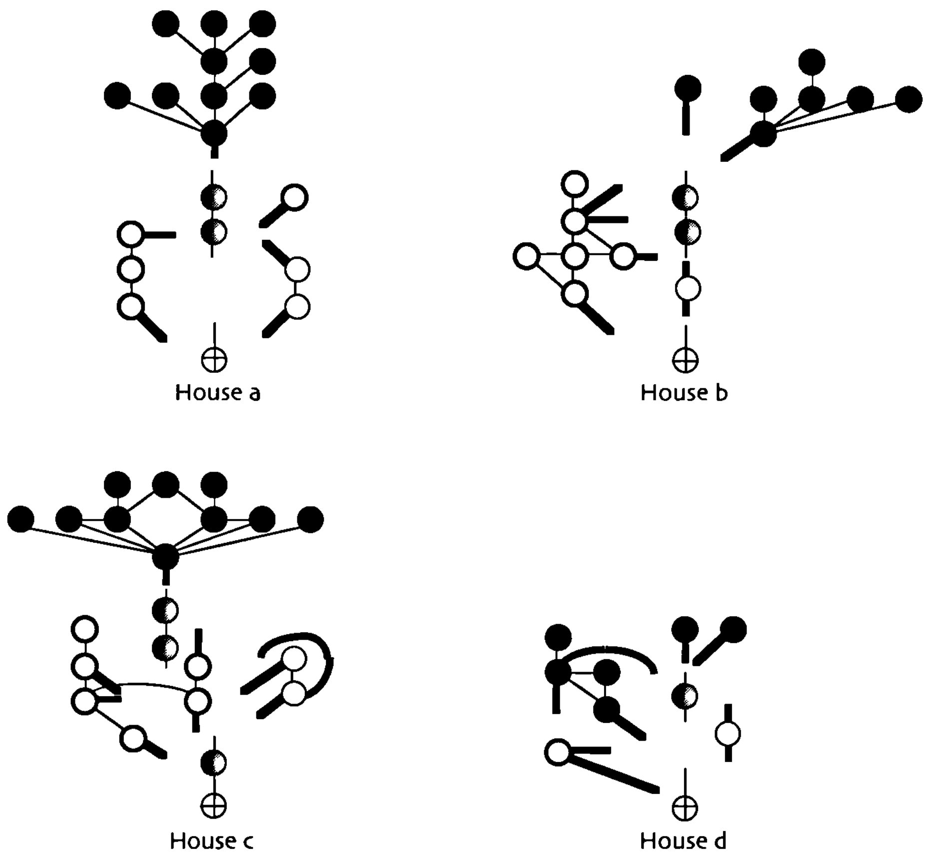


Figure 6.3. Justified graphs with the sectors' connectivity highlighted

These highly controlled sectors contrast with, for example, the ringy sector in house b. They are highly permeable, allowing access from different parts of the sub-system to the neighbour sectors. In some cases, rings are formed throughout adjacent sectors which, when added to a higher degree of accessibility, can blur their common boundaries. These 'fuzzy boundaries' express a contrasting figure with the ones seen previously. Movement is less controlled and the interface between the users of permeable sectors is likely to occur with more frequency and informality, unless these boundaries are open and closed according to especial circumstances. In this case, time factor is fundamental to multiply the configurational possibilities stated by the plan. The identification of spaces which controls such boundaries seems to be of vital importance.

These different configurations can be quantified by numbering the links between the sectors. The 'sectors' connectivity' can be relativised by the total number of spaces which compose the sector, as seen in the equation:

$$DP = \frac{sc - 1}{n} \qquad [12]$$

where *DP* stands for 'degree of permeability'; *sc* for sectors' connectivity; and *n* for the number of spaces in the sector. When the sectors' connectivity is equal to 1.00, the degree of permeability is said to be 0.00, as it describes the simpler form of permeability between spaces, and therefore sectors.

The degree of permeability, different from the relative connectivity, can assume values over 1.00, and well over it. If the degree of permeability is very low, it means that the sector is organised in such a way as to segregate the categories of users and activities from the rest of the system. If the value is high, it means that the interaction between different categories is allowed, or rather structured by the space layout itself. If a sector follows the first model, then it is said that it has a 'clear boundary', while if it follows the second model, then its boundary is said to be 'fuzzy'.

6.2.3. Towards a sectors' typology

These two measures, the degree of permeability (DP) and relative connectivity (RC), are the necessary tools to examine the configuration of the sectors. The combination of such measures raises some theoretical typologies. Figure 6.4. plots the relative connectivity, or the internal characteristics of the sectors, on the horizontal axis, and the degree of permeability, or the external properties of the sectors, on the vertical axis. The 'box' suggests the existence of four types of relationships between the two measures, hence generating four families of sectors.

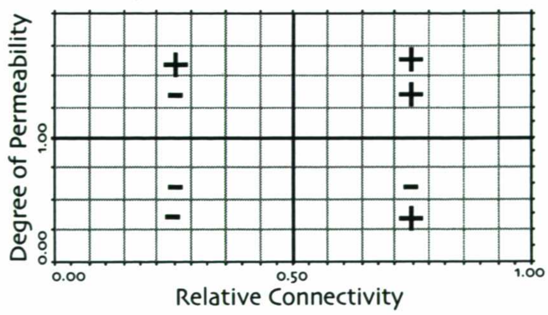


Figure 6.4. The 'sectors' box'

The first family has low DP and RC values, i.e., it combines still boundaries with internal tree-like structures. It is generated by a strongly programmed form of spatial organisation, where movement is highly programmed and categories of users are strictly spatialised. This family occupies the minus/minus quadrant. The second family has clear boundaries (low DP) but its internal structure is very ringy (high RC). This model represents a particular situation where the relation between sectors, therefore of categories of users, is highly controlled, but the interaction amongst the members of the sector is unprogrammed. The second family occupies the minus/plus quadrant. The third family groups the sectors with fuzzy boundaries (high DP) and ringy internal structures (high RC), therefore occupying the plus/plus quadrant. These sectors are the expression of a weak program, which allows the highest possible interaction among different categories of people and activities which conform the life of the building. The last family comprises the sectors with fuzzy boundaries, but with low RC values (plus/minus quadrant). These sectors build up an intense relationship with other sectors, but are strongly categorised.

The demarcation of the plus-minus boundaries is defined as follows. The relative connectivity varies from 0.00 to 1.00, but the degree of permeability has non-limited values. This means that the level of 0.50 relative connectivity can be defined as a horizontal boundary, on the simple basis of a mathematical average value. However, it must be highlighted that, because of the lack of an extensive application of this method to diverse building types, and indeed, domestic buildings as well, this boundary is completely artificial. It may be possible that high RC values may be very difficult to be found, and therefore the abstract low/high boundary may have to be redefined on the basis of extensive empirical studies.

It is more difficult to establish a parameter for the degree of permeability because its values have no specific range, but one form to define the vertical boundary that would characterise the high/low fuzziness of the sectors is by taking as reference the DP value of 1.00. This is because this value is achieved when the sectors' connectivity exceeds the number of spaces by one. This first level of 'saturation' of the sectors' connectivity is fundamental, because it specifies the relative openness of the sector.

However, the likelihood of achieving such a degree of permeability in large complexes is improbable. For this reason, the vertical boundary can be stretched to form a 'transitional area' in which the relative permeability of large complexes may be considered. The demarcation of the limits of this transitional area is defined by a numerical series which generates the same DP value compensating for the increase of sectors' size with less number of sectors' connections. The series is formed by the pairs 2:2, 4:3, 6:4, 8:5, 10:6, ..., in which the first number represents the number of spaces of a sector and the second its connectivity. This series always results in a DP value of 0.50, which is taken as a boundary for the transitional area.

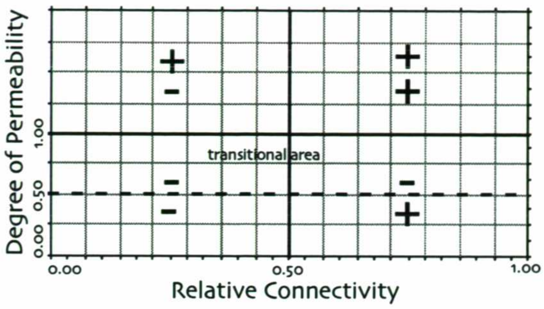


Figure 6.5. The sectors' box with transitional area

The next sections use this methodological procedure to model a sample of modern and pre-modern houses representative of the diverse forms of sectors' organisation identified in chapters three and five. The houses are represented as minimal living complexes rooted from the outside complexes (the carrier space). In the cases where the outside complex is split into two or more sub-complexes, each of them is represented as a single node in the graph. The graphs are justified from the node which is directly connected to the exterior (street). The houses are firstly described by their architectural features, and secondly, the degree of permeability (DP) and relative connectivity (RC) of their sectors are assessed. The results are compared within each sample in order to identify general properties and odd occurrences. Firstly, the main sectors - social, service, private and mediator - are plotted in the sectors' box, observing their relative position and therefore their properties in being fuzzy or clear, ringy or tree-like. Secondly, the main sectors are plotted all together per house, describing the characteristics of the house as a whole. Finally, the modern, eclectic and colonial sample are compared, in order to assess some similarities in their sectors' composition.

6.3. On the study of the structure of Recife's domestic sectors

6.3.1. The sample

The sub-sample of pre-modern houses is composed of nine colonial and ten eclectic dwellings. The colonial sample consists of five *casas térreas* and four *sobrados*. The inclusion of all *sobrados* present in the colonial sample responds to the variety of sectors' types found amongst these dwellings. The eclectic sub-sample includes exemplars of ground-floor-non-mediated (types *Ta* to *Tj*) and first-floor-mediated houses (types *Tk* to *Tp*). The non-mediated houses are the most popular amongst the eclectic houses (71.88% of the sample), whereas the mediated dwellings are only found in nine houses (28.12%). The higher number of phenotypical sectors' arrangements amongst the mediated dwellings determined the inclusion of a proportionally high number of mediated houses in the sub-sample. The final composition of the eclectic sub-sample includes five representatives of each type.

The modern sub-sample comprises twenty modernist dwellings, also accommodating the non-mediated (types T1 to T4, T13 and T14) and the mediated houses (types T5 to T12 and T15 to T40). The non-mediated houses correspond to 18.93 % (39 houses) of the modern sample, from which six exemplars are extracted for analysis. Three are ground-floor houses, one has a mezzanine and the remaining two are in levels. Mediation is found in a variety of numbers and modes. Single mediated houses are the most common in the modern sample (71.84%), double mediation is found in seven cases (3.39%) and triple mediation in a single case (0.48%). Fourteen houses complete the modernist sub-sample: four ground floor units, seven multi-storey, one with mezzanine and one with basement.

The first aspect to be discussed, in sub-section 6.3.2., is the structure of the colonial, eclectic and modern houses. This analysis is developed diachronically, by observing the composition of the houses according to the form in which their sectors are internally and externally structured. The analysis continues by trying to characterise the three samples according to the structure of their main sectors - visitors', family, service, private and mediator. In sub-section 6.3.3., the houses are evaluated according to their mean RC and DP values, whereas in sub-section 6.3.4., the typical colonial, eclectic and modern houses are proposed, according to the typical structure of their sectors. The analysis is concluded, in sub-section 6.3.5., by summarising the evolutionary changes in the structure of the sectors. Figures 6.6. to 6.8. present the plans, convex maps and justified graphs of the pre-modern and modern houses, and tables 6.5. to 6.7. synthesise the results of the analysis for the pre-modern and modern samples, respectively.

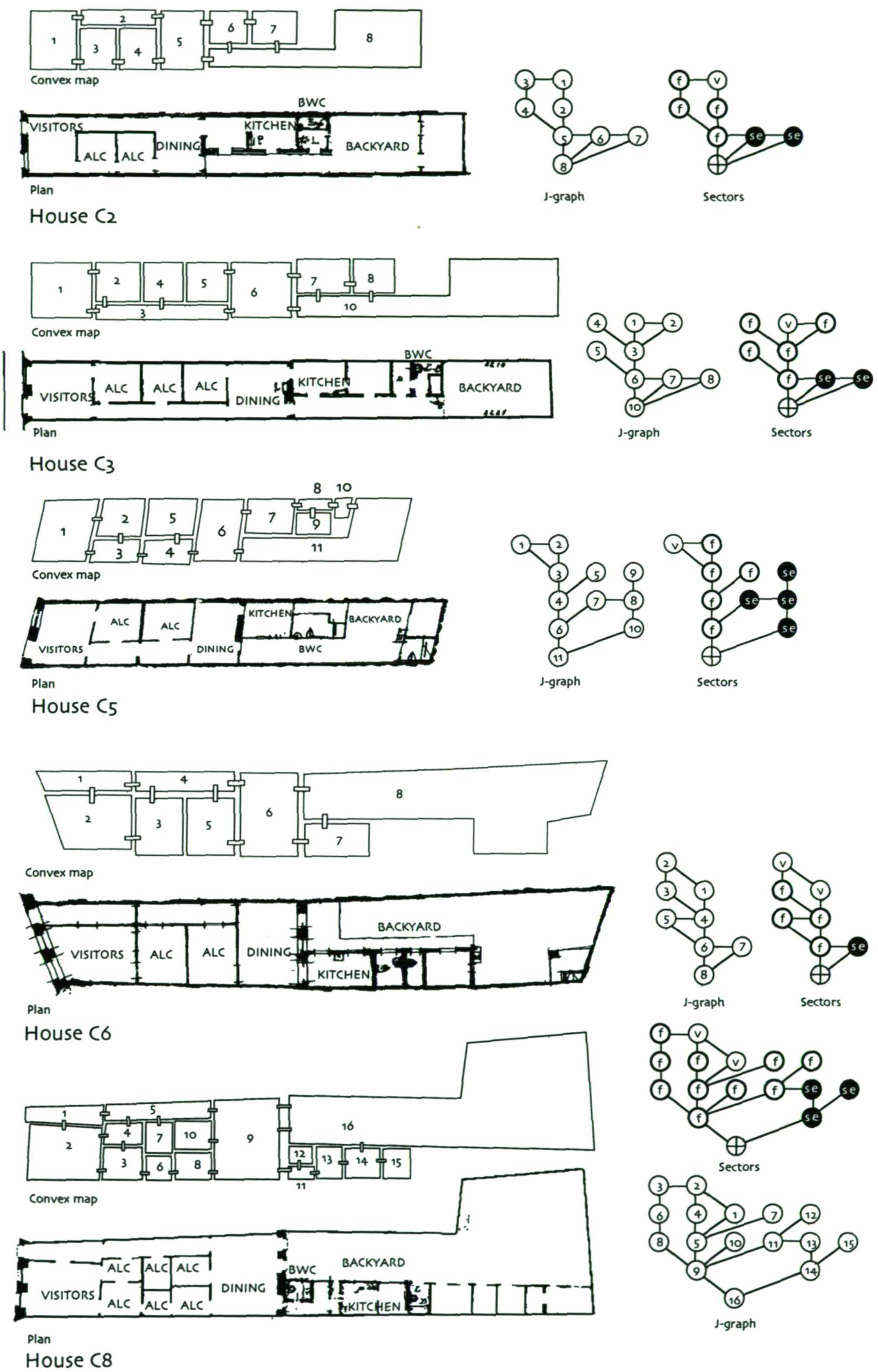
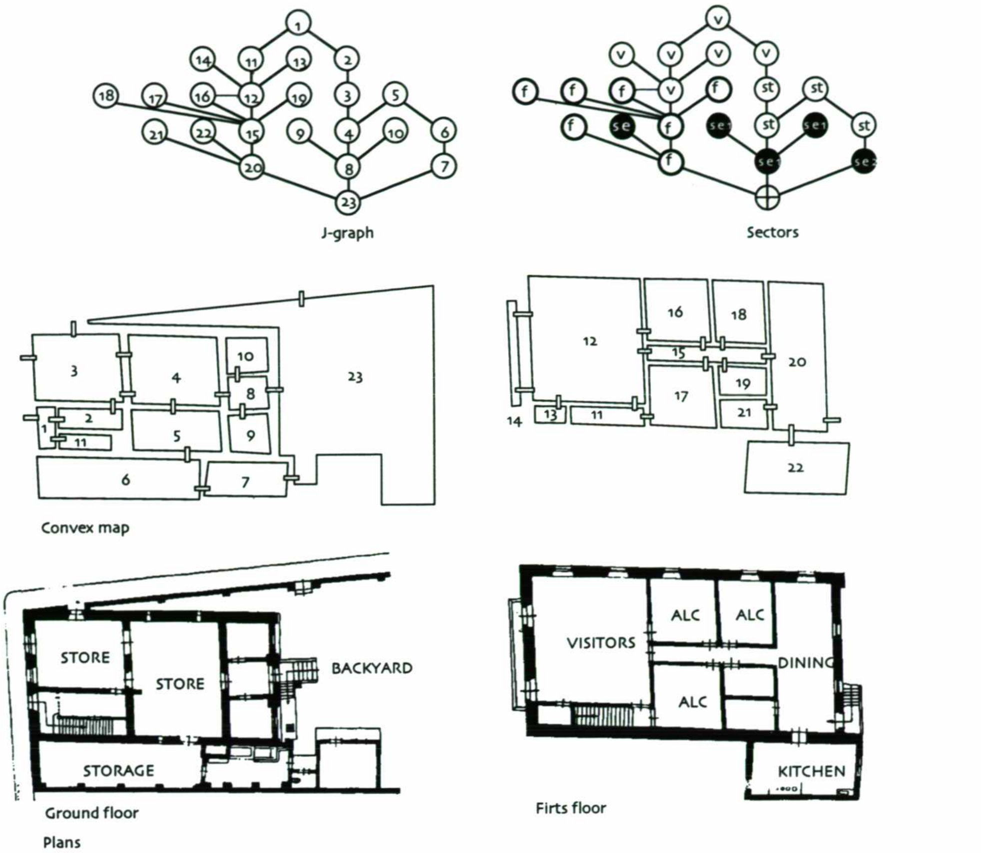
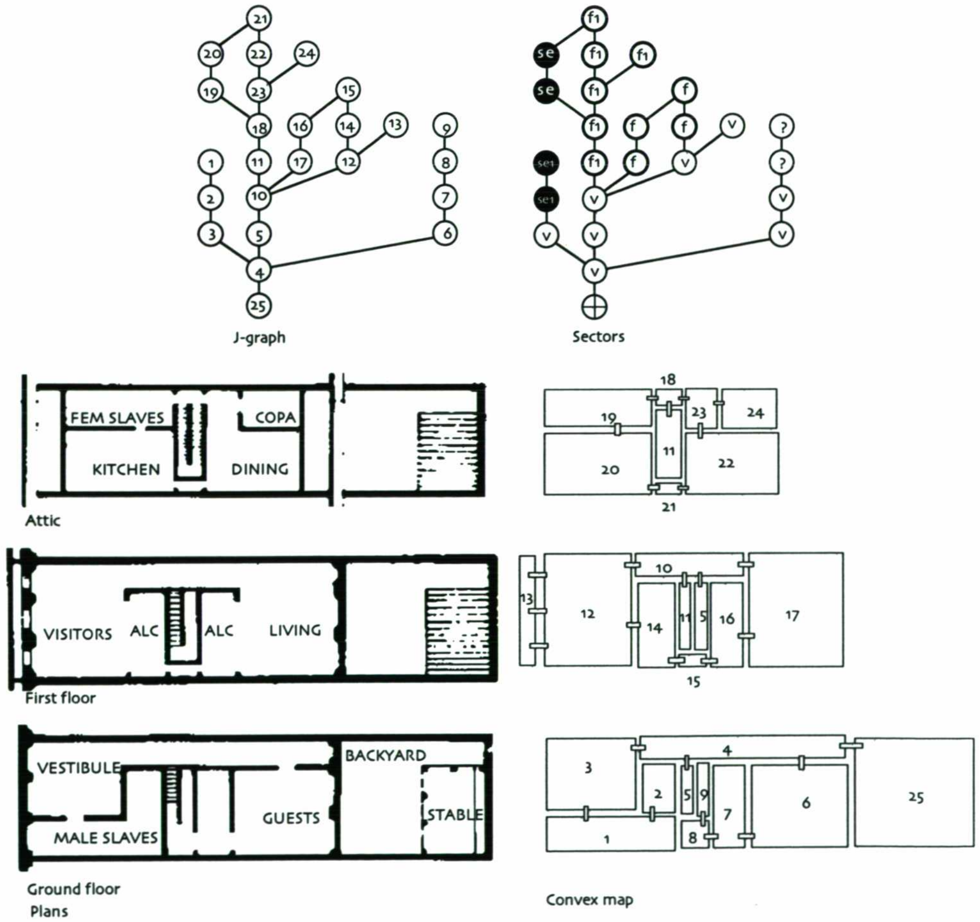


Figure 6.6. Colonial houses: plans, convex map and justified graphs



House C13



House C12

Figure 6.6. Colonial houses: plans, convex map and justified graphs (continued)

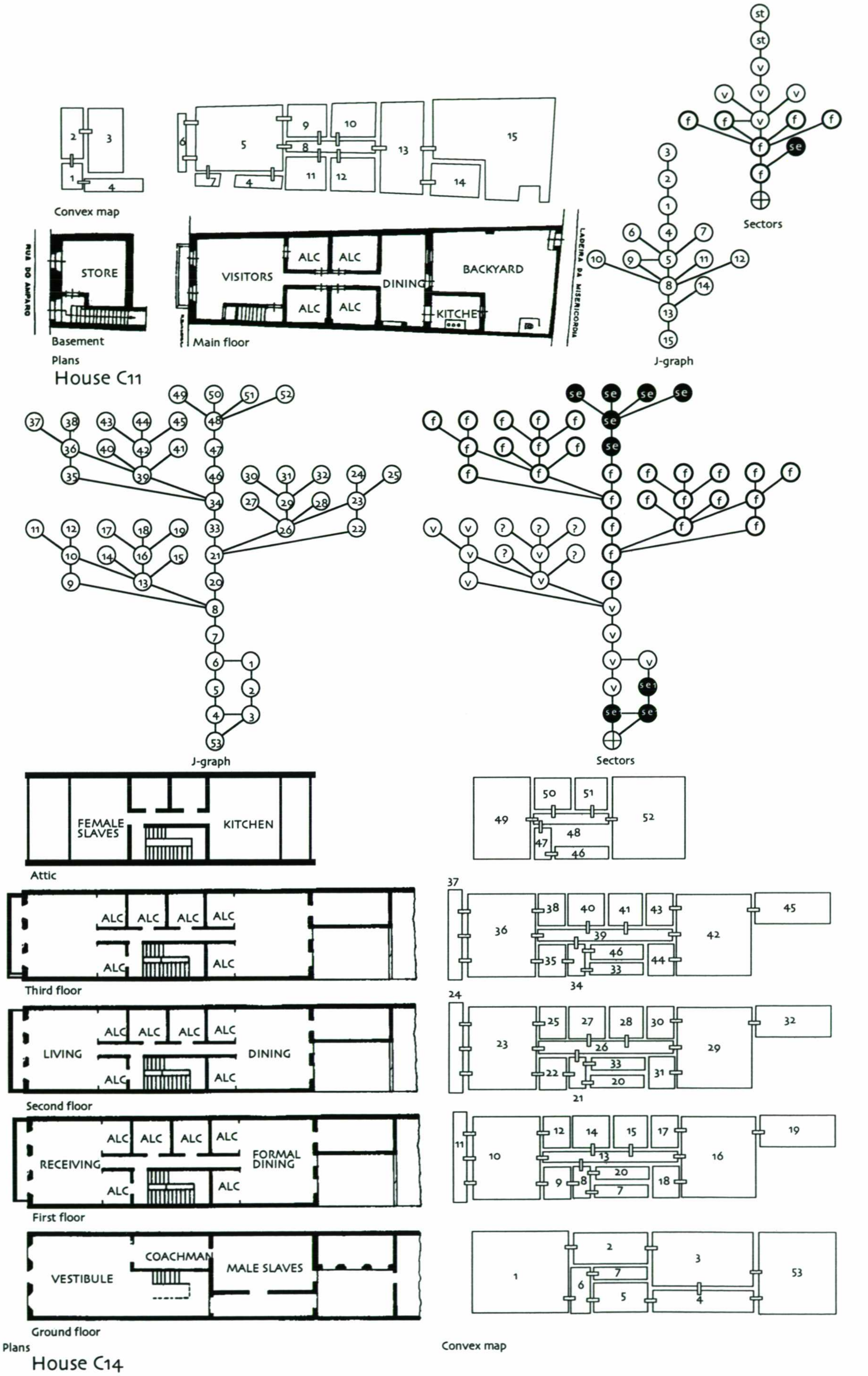


Figure 6.6. Colonial houses: plans, convex map and justified graphs (continued)

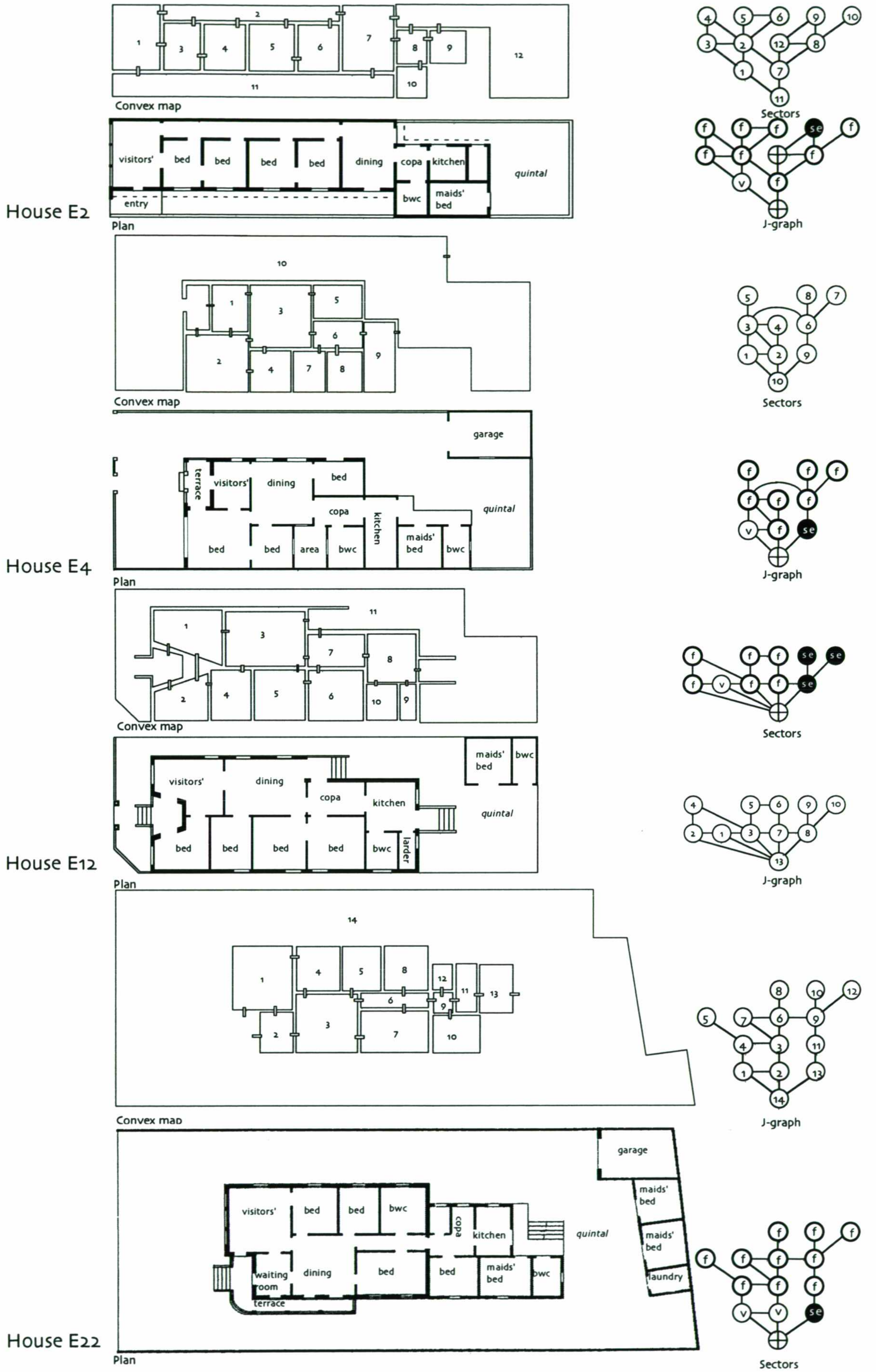


Figure 6.7. Eclectic houses: plan, convex maps and justified graphs

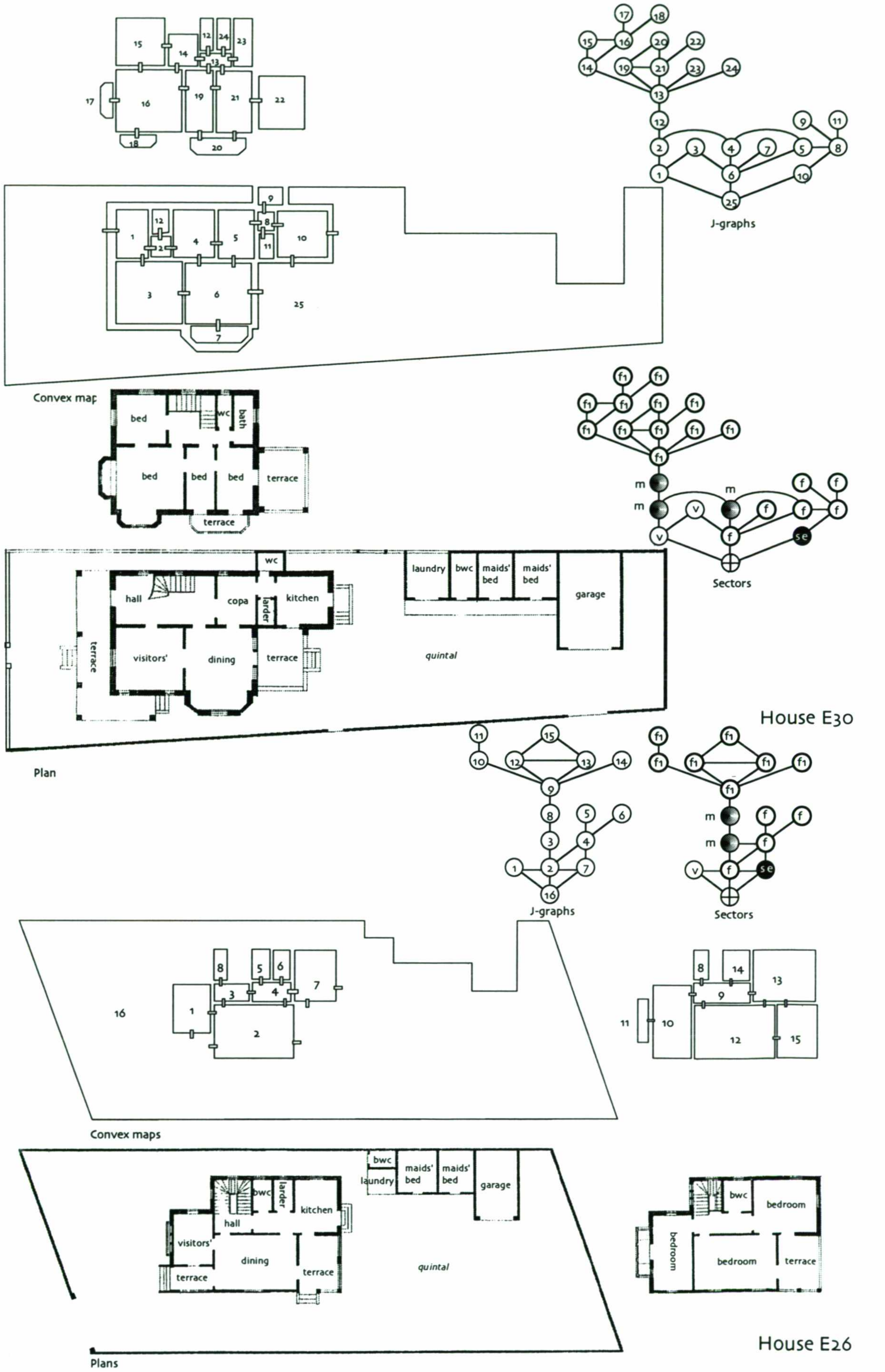


Figure 6.7. Eclectic houses: plan, convex maps and justified graphs (continued)

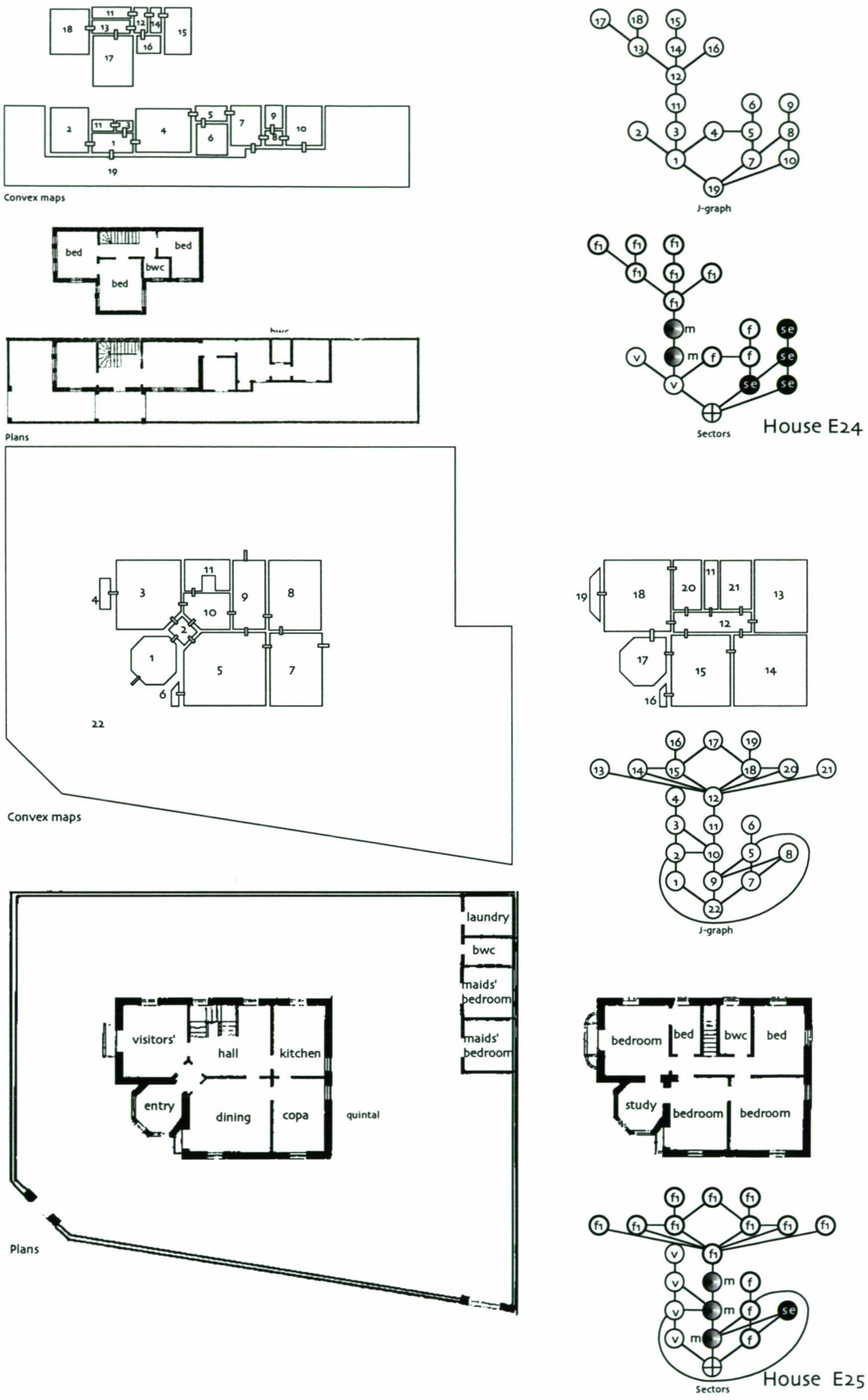


Figure 6.67. Eclectic houses: plan, convex maps and justified graphs (continued)

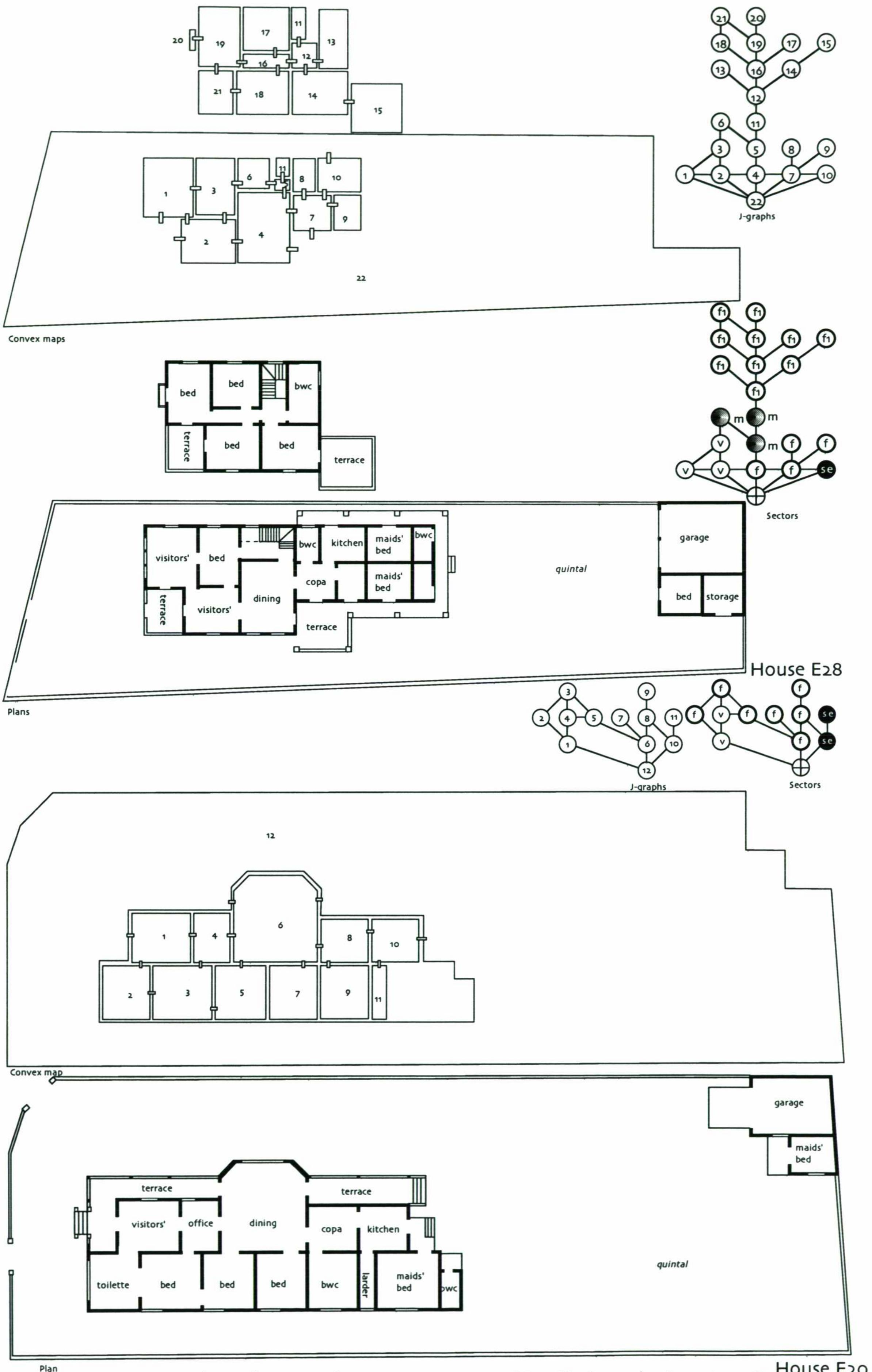


Figure 6.7. Eclectic houses: plan, convex maps and justified graphs (continued)

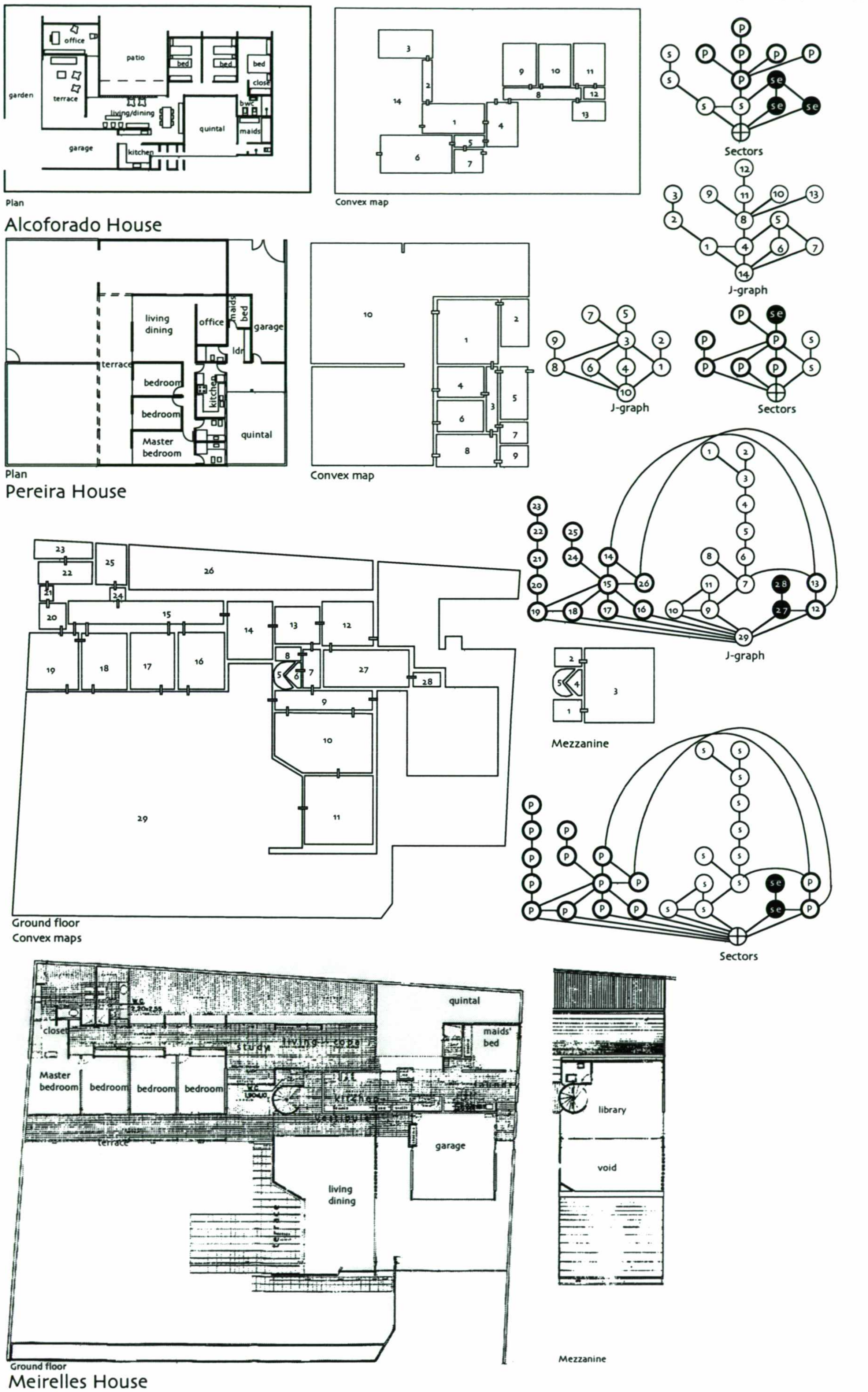
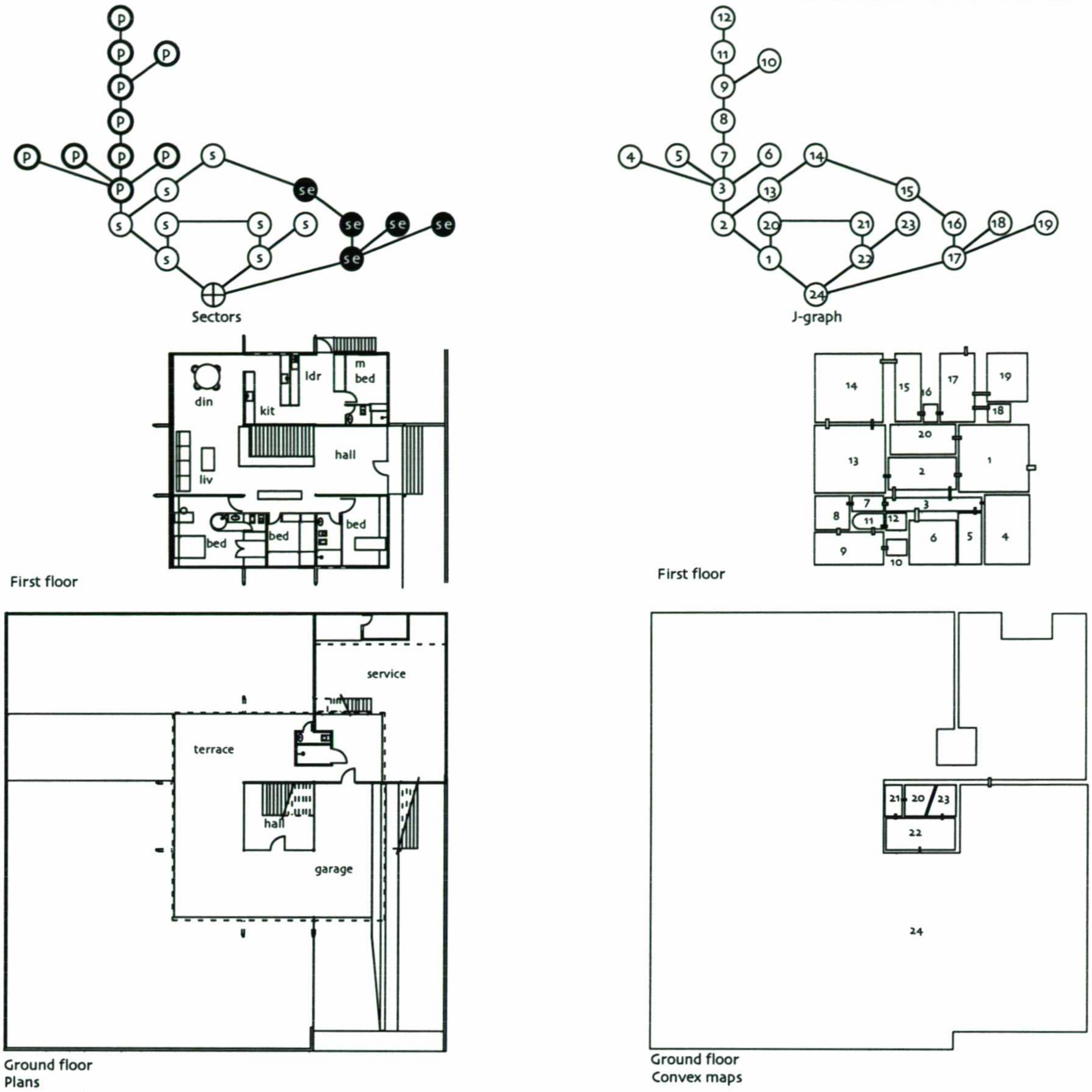
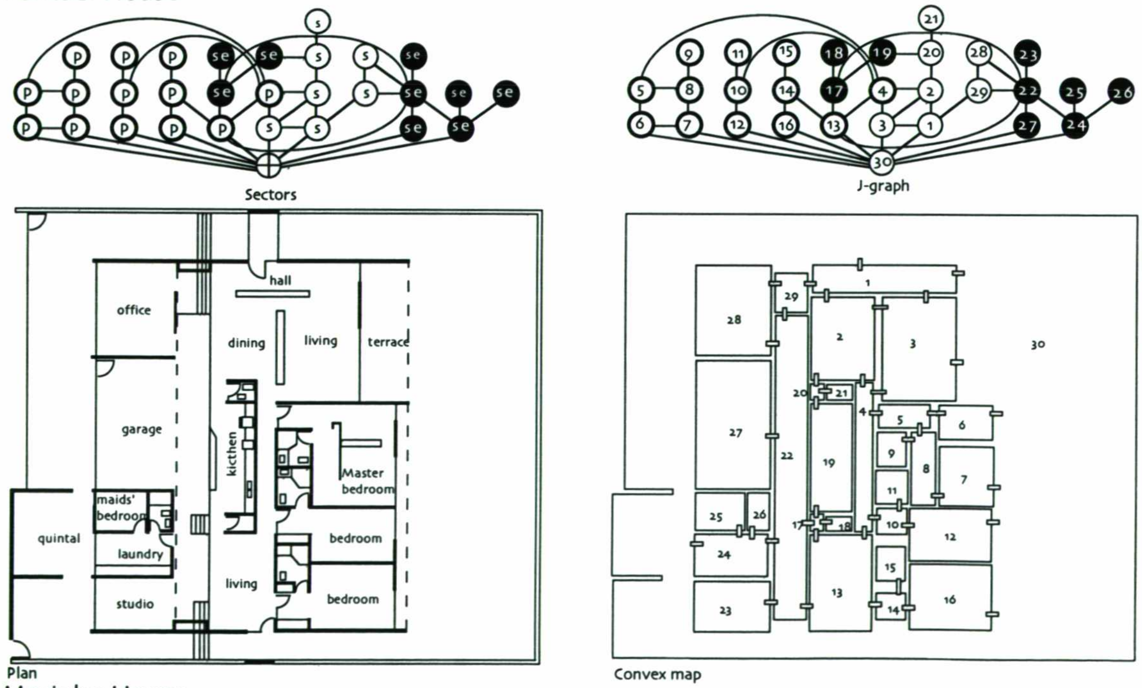


Figure 6.8. Modern houses: plans, convex maps and justified graphs



Pontual House



Marinho House

Figure 6.8. Modern houses: plans, convex maps and justified graphs (continued)

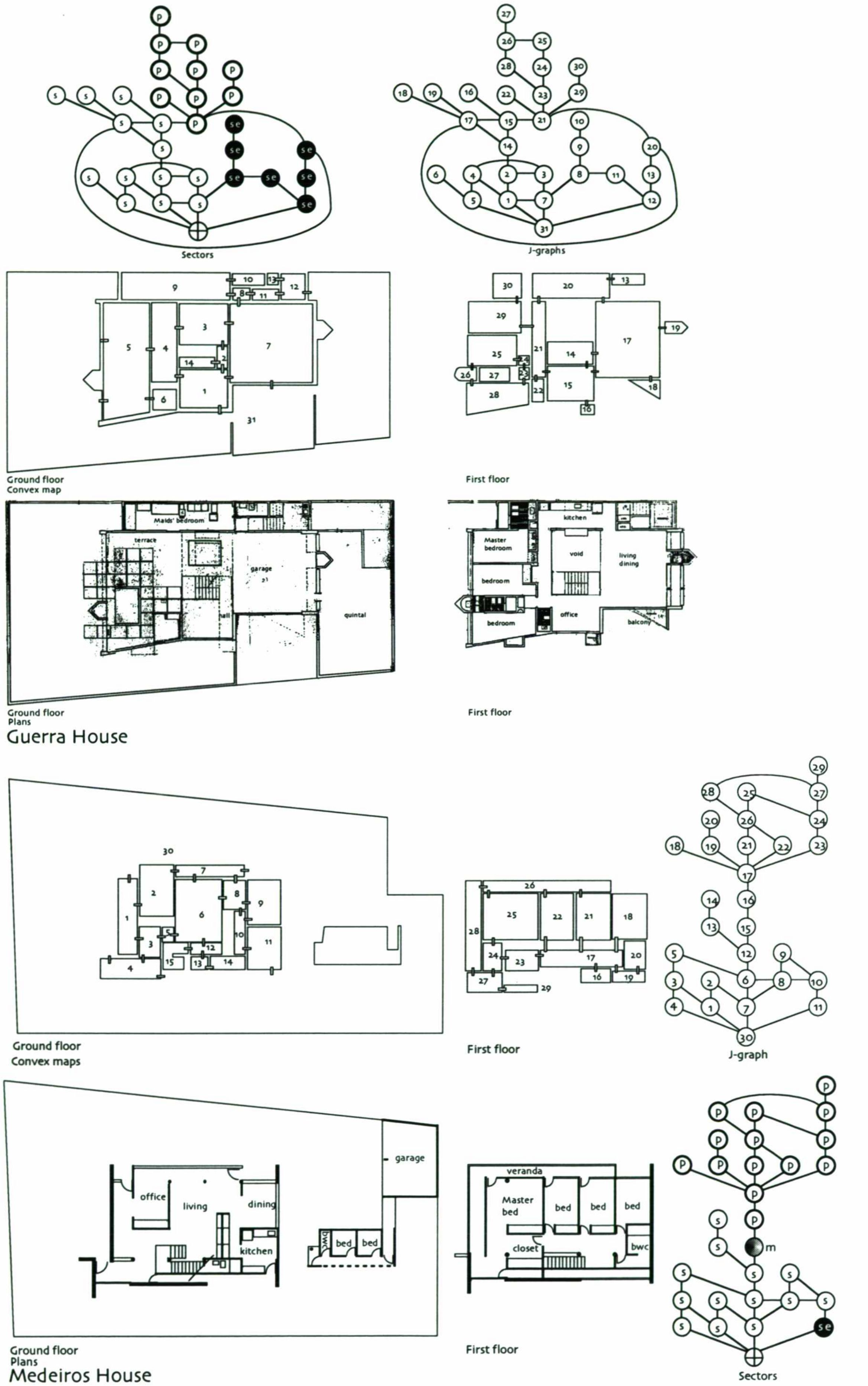


Figure 6.8. Modern houses: plans, convex maps and justified graphs (continued)

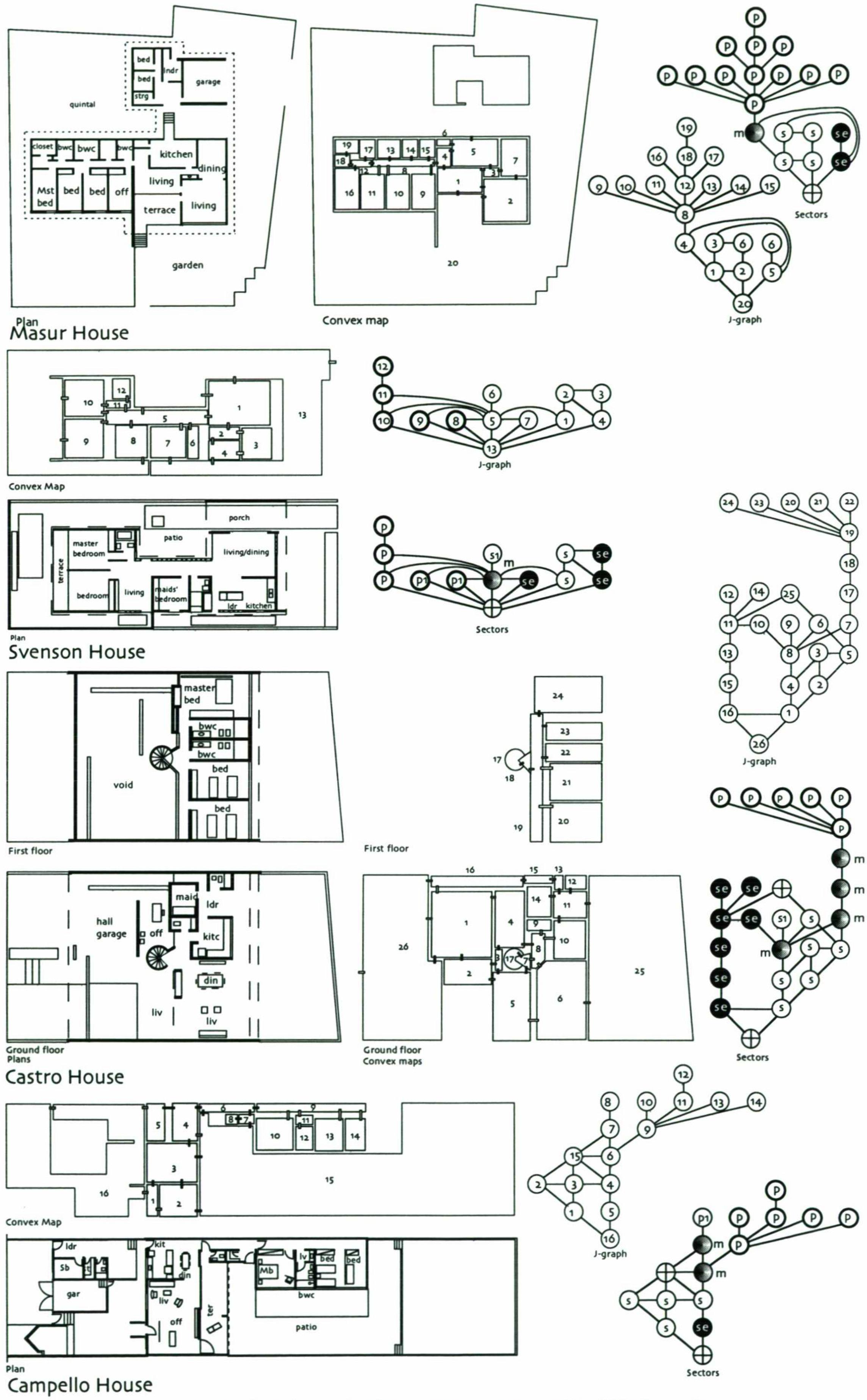


Figure 6.8. Modern houses: plans, convex map and justified graphs

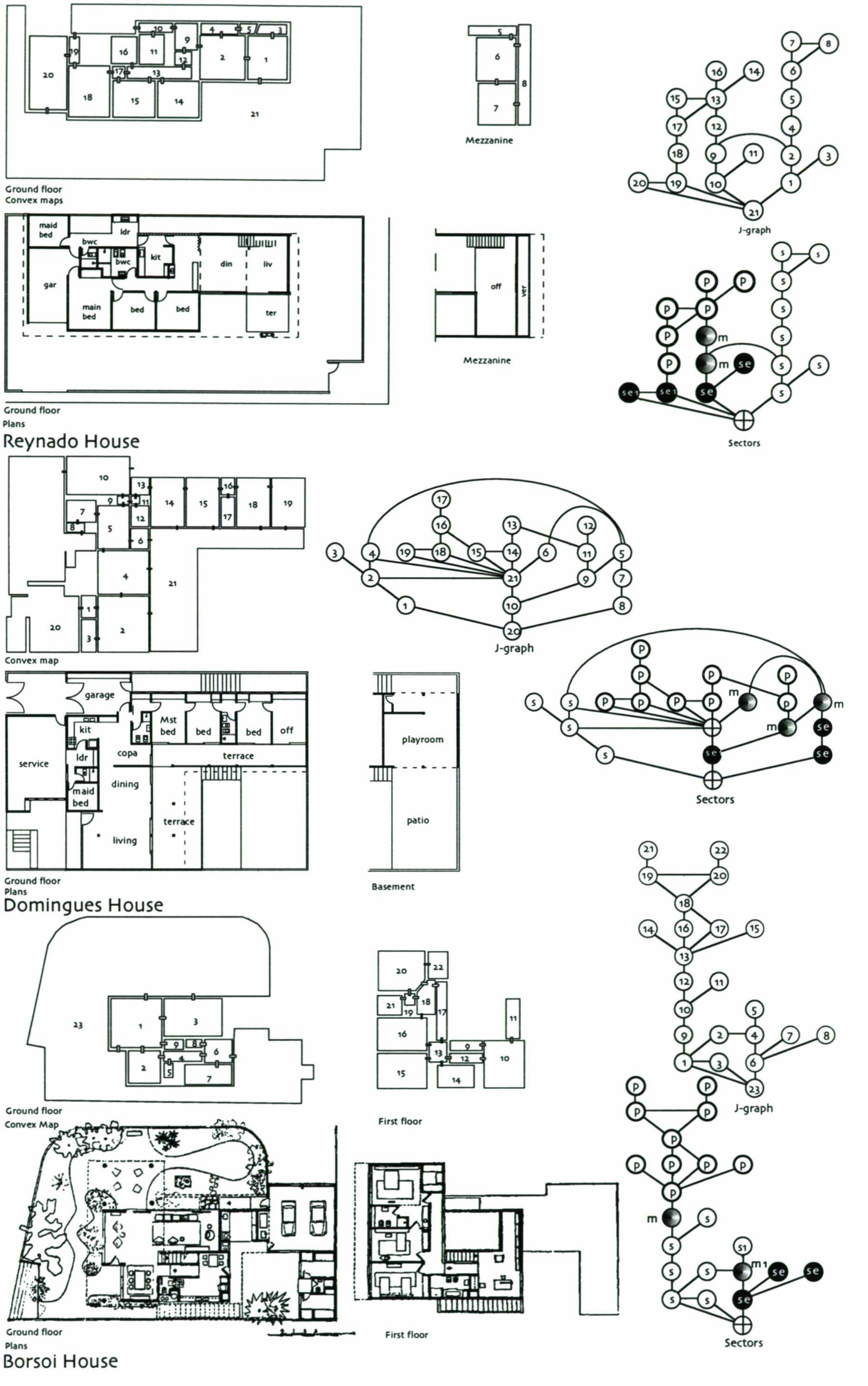
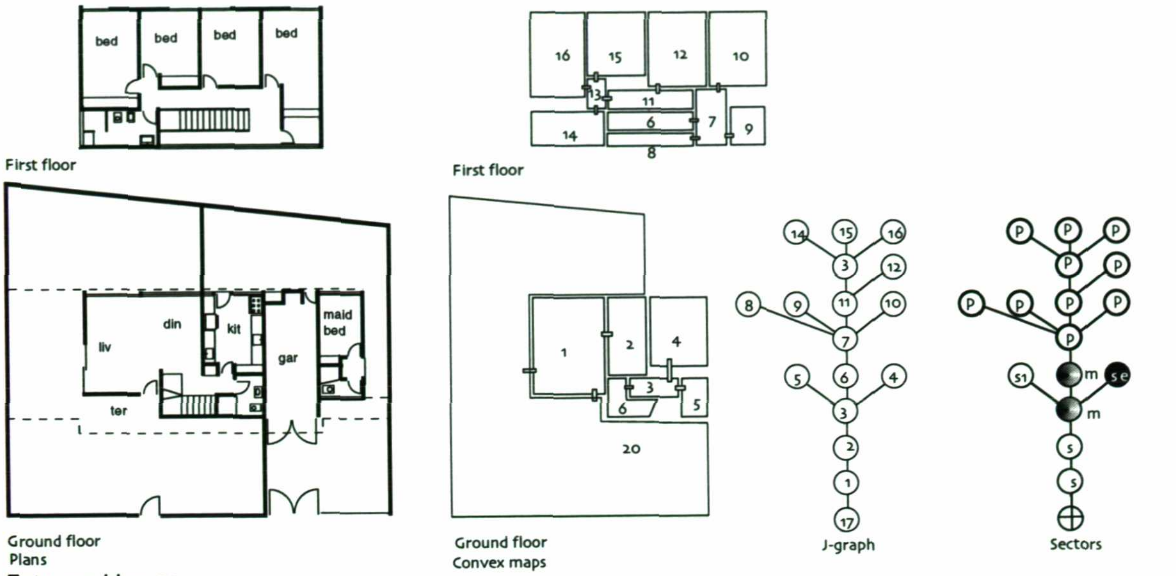
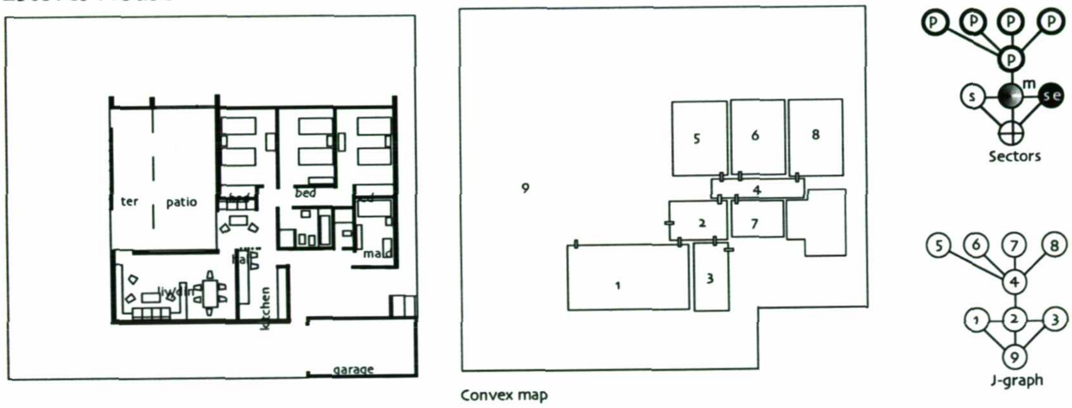


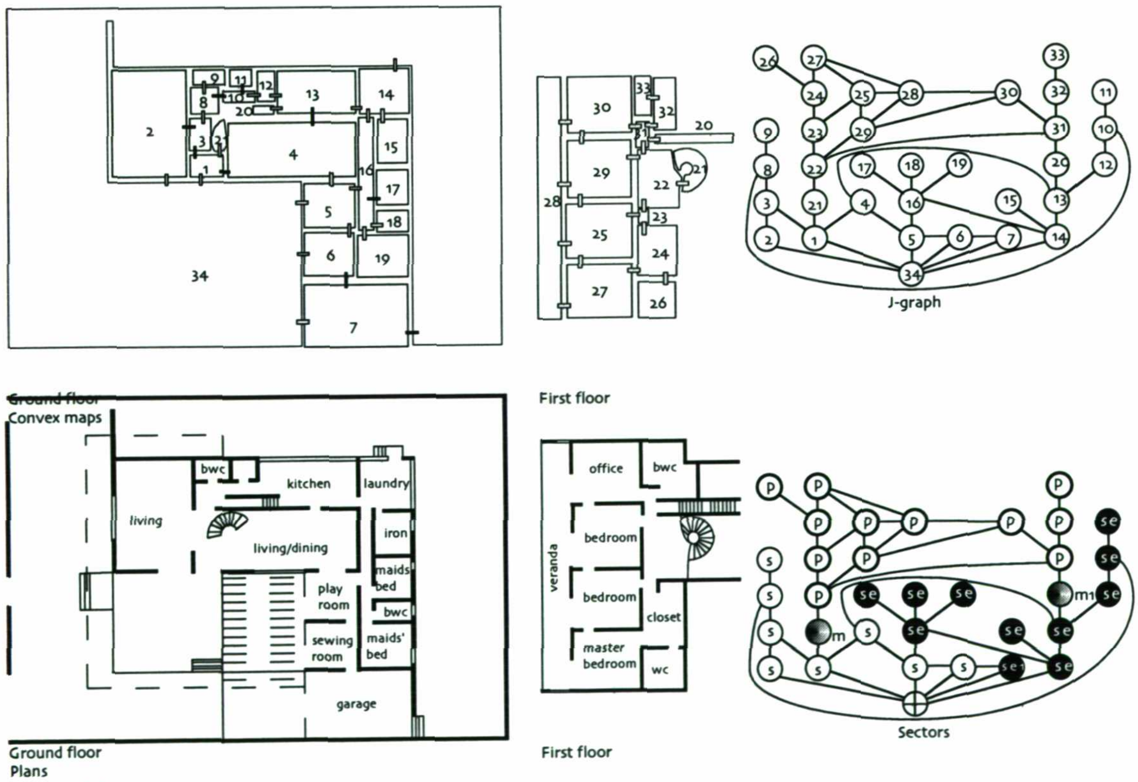
Figure 6.8. Modern houses: plans, convex map and justified graphs



Esteves House

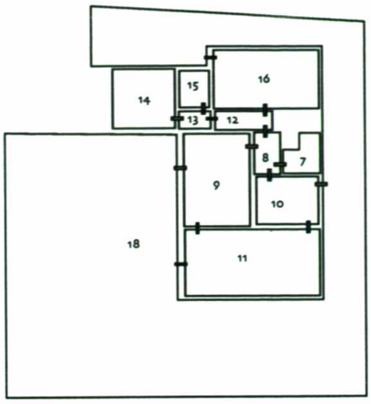


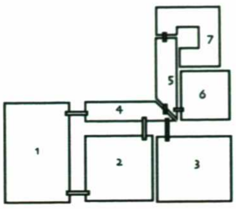
Melo House



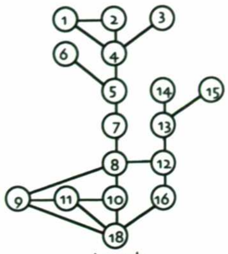
Lages House

Figure 6.8. Modern houses: plans, convex maps and justified graphs (continued)



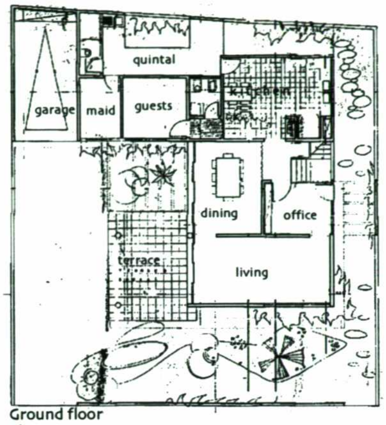


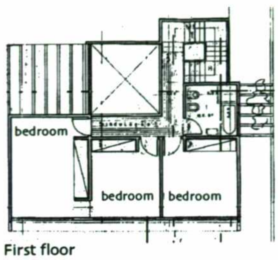
First floor



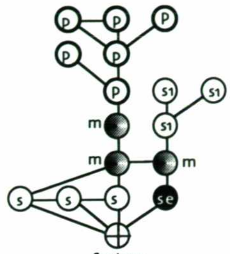
J-graph

Ground floor
Convex maps





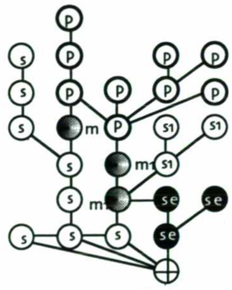
First floor



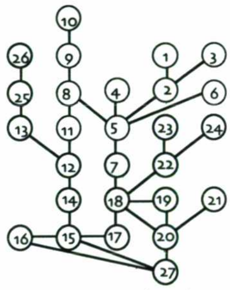
Sectors

Ground floor
Plans

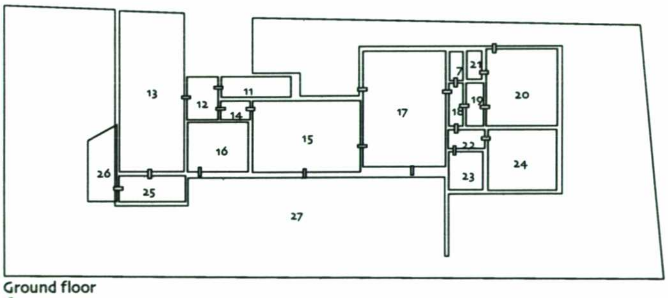
Chamixaes House



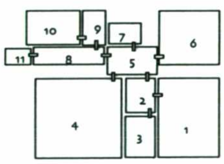
Sectors



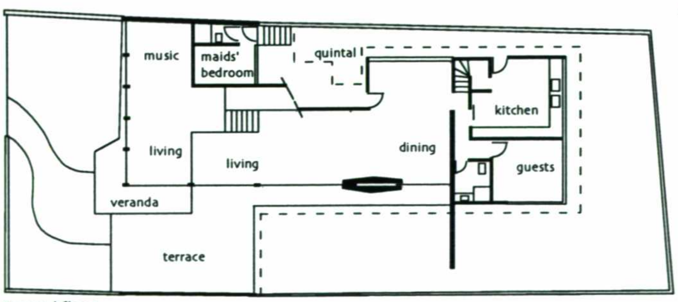
J-graph

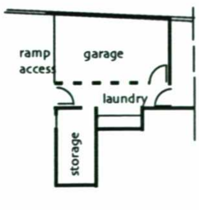


Ground floor
Convex maps

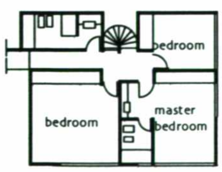


First floor





Basement

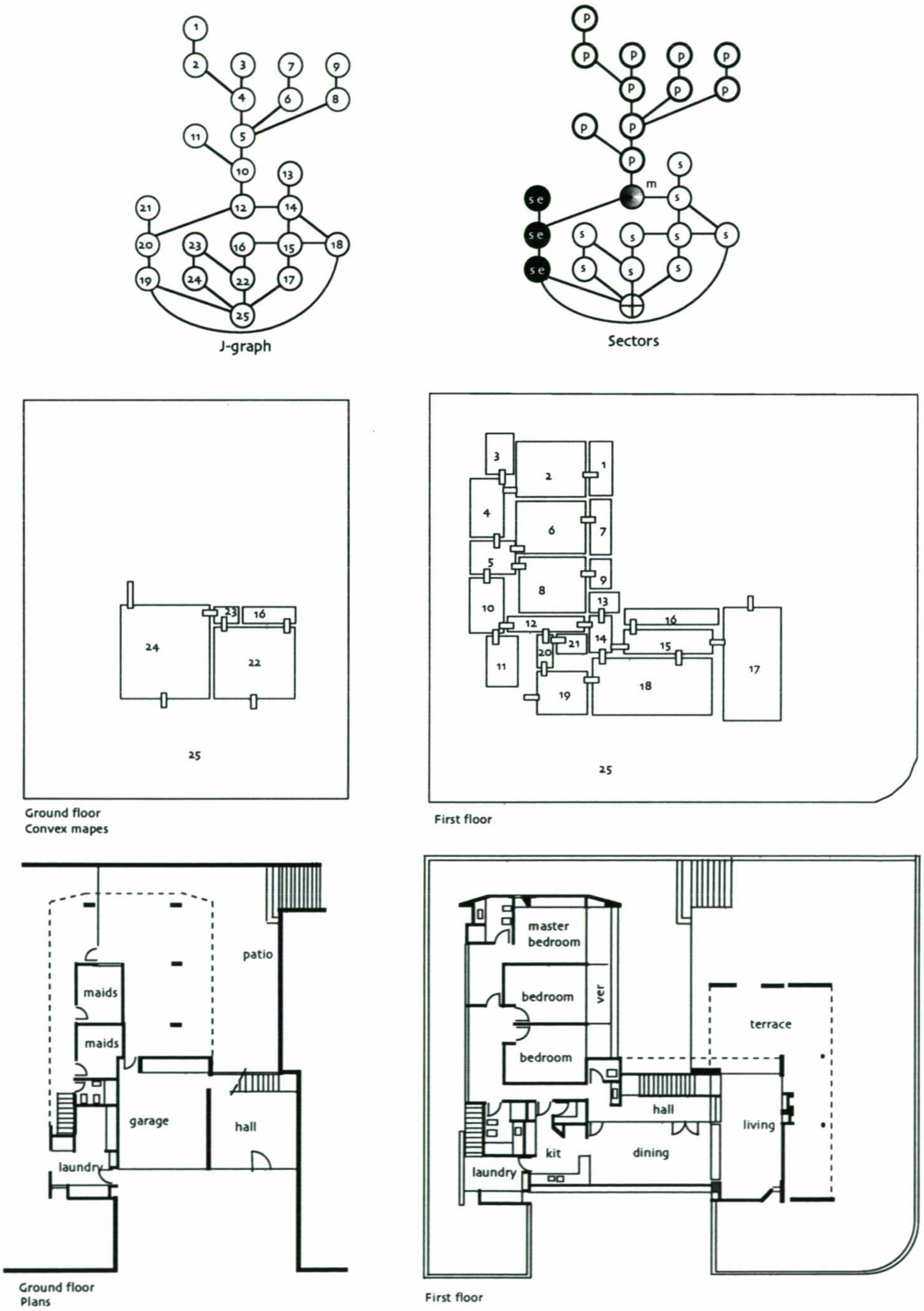


First floor

Ground floor
Plans

Claudio House

Figure 6.8. Modern houses: plans, convex maps and justified graphs (continued)



Berinson House

Figure 6.8. Modern houses: plans, convex maps and justified graphs (continued)

Table 6.5. The structure of the colonial sectors

House	Type	Size								Relative Connectivity (RC)									Degree of Permeability (DP)							
		t	v	f	f1	se	se1	se2	st	house	MRC	v	f	f1	se	se1	se2	st	MDP	v	f	f1	se	se1	se2	st
C2	Ta	7	1	4		2				0.27	0.00	0.00	0.00		0.00				0.92	1.00	0.75		1.00			
C3	Ta	8	1	5		2				0.23	0.00	0.00	0.00		0.00				0.87	1.00	0.60		1.00			
C5	Ta	10	1	5		4				0.12	0.00	0.00	0.00		0.00				0.62	1.00	0.60		0.25			
C6	Td	7	2	4		1				0.27	0.11	0.00	0.33		0.00				0.75	0.50	0.75		1.00			
C8	Ta	15	2	10		3				0.11	0.00	0.00	0.00		0.00				0.58	1.00	0.40		0.33			
C11	Tf	14	5	6		1			2	0.00	0.00	0.00	0.00		0.00			0.00	0.23	0.40	0.50		0.00			0.00
C12	Th	22	8	4	6	2	2			0.04	0.00	0.00	0.00	0.00	0.00	0.00			0.32	0.50	0.25	0.33	0.50	0.00		
C13	Tg	24	6	7	1	3	1	2	4	0.05	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.43	0.33	0.43		0.00	0.33	1.00	0.50
C14	Te	22	8	4	6	2	2			0.04	0.01	0.00	0.04		0.00	0.00			0.30	0.04	0.18		0.00	1.00		
Mean		14.33	3.78	5.44	4.33	2.22	1.67	2.00	3.00	0.13	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.56	0.64	0.50	0.33	0.45	0.44	1.00	0.25

Table 6.6. The structure of the eclectic sectors

House	Type	Med	Size						Relative Connectivity (RC)							Degree of Permeability (DP)					
			t	v	f	f1	se	m	house	MRC	v	f	f1	se	m	MDP	v	f	f1	se	m
E2	Ta	n-m	10	1	8		1		0.26	0.03	0.00	0.09		0.00		1.04	2.00	0.63		0.50	
E4	Tb	n-m	9	1	7		1		0.31	0.04	0.00	0.11		0.00		1.14	2.00	0.43		1.00	
E12	Tc	n-m	10	1	6		3		0.35	0.05	0.00	0.14		0.00		0.93	2.00	0.45		0.33	
E20	Ti	n-m	11	2	7		2		0.21	0.00	0.00	0.00		0.00		0.86	1.50	0.57		0.50	
E22	Tb	n-m	13	2	10		1		0.17	0.02	0.00	0.07		0.00		0.90	1.50	0.20		1.00	
E24	Tm	m	18	2	3	7	4	2	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.47	1.00	0.33	0.00	0.50	0.50
E25	Tp	m	21	4	3	10	1	3	0.21	0.05	0.00	0.00	0.23	0.00	0.00	0.82	0.75	0.67	0.00	1.00	1.67
E26	Tn	m	15	1	4	7	1	2	0.22	0.04	0.00	0.00	0.22	0.00	0.00	1.05	1.00	1.25	0.00	2.00	1.00
E28	To	m	21	3	4	10	1	3	0.18	0.21	1.00	0.00	0.07	0.00	0.00	0.73	1.00	1.00	0.00	1.00	0.67
E30	Tl	m	24	2	6	12	1	3	0.16	0.03	0.00	0.00	0.16	0.00	0.00	0.73	1.00	0.67	0.00	1.00	1.00
Mean all			15.20	1.90	5.80	9.20	1.60	2.60	0.22	0.06	0.10	0.04	0.14	0.00	0.00	0.77	1.38	0.62	0.00	0.88	0.97
Mean non-mediated			15.72	1.40	7.60		1.60		0.26	0.03	0.00	0.08		0.00		0.97	1.80	0.46		0.67	
Mean mediated			16.39	2.40	4.00	9.20	1.60	2.60	0.17	0.07	0.20	0.00	0.14	0.00	0.00	0.76	0.95	0.78	0.00	1.10	0.97

Table 6.7. The structure of the modern sectors

House	Size									Relative Connectivity (RC)										Degree of Permeability (DP)								
	t *	s	s1	se	se1	p	p1	m	m1	House	MRC	s	s1	se	se1	p	p1	m	m1	MDP	s	s1	se	se1	p	p1	m	m1
Non-mediated																												
Alcoforado	13	4		3		6				0.13	0.00	0.00		0.00		0.00				0.47	0.75		0.67		0.00			
Pereira	9	2		1		6				0.20	0.00	0.00		0.00		0.00				0.39	0.50		0.00		0.67			
Meirelles	28	11		2		15				0.21	0.06	0.06		0.00		0.12				0.36	0.18		0.50		0.40			
Marinho	29	7		9		13				0.27	0.05	0.11		0.00		0.05				0.69	0.67		0.78		0.62			
Guerra	30	13		7		10				0.16	0.07	0.14		0.00		0.07				0.26	0.24		0.43		0.10			
Pontual	23	8		5		10				0.05	0.00	0.00		0.00		0.00				0.19	0.38		0.20		0.00			
Mean	22.00	7.50		4.50		10				0.17	0.03	0.05		0.00		0.04				0.39	0.45		0.43		0.30			
Mediated																												
Medeiros	29	13		1		14		1		0.16	0.07	0.14		0.00		0.13		0.00		0.58	0.31		1.00		0.00		1.00	
Reynaldo	22	8		4	2	6		2		0.14	0.05	0.09		0.00	0.00	0.14		0.00		0.54	0.05		0.50	1.00	0.17		1.00	
Chamixaes	17	3	3	1		6		3		0.13	0.00	0.00	0.00	0.00		0.00		0.00		0.73	1.33	0.00	1.00		0.00		1.33	
Melo	8	1		1		5		1		0.15	0.00	0.00		0.00		0.00		0.00		1.25	1.00		1.00		0.00		3.00	
Esteves	16	2	1	1		10		2		0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.40	0.50	0.00	0.00		0.00		1.50	
Domingues	20	4		3	1	9		3		0.29	0.00	0.00		0.00	0.00	0.00		0.00		1.00	0.75		0.50	2.00	0.50		1.25	
Berinson	24	9		3		11		1		0.11	0.02	0.08		0.00		0.00		0.00		0.78	0.44		0.66		0.00		2.00	
Masur	19	4		2		12		1		0.11	0.08	0.33		0.00		0.00		0.00		0.94	0.75		1.00		0.00		2.00	
Campello	14	4		1		6		2		0.22	0.08	0.33		0.00		0.00		0.00		1.06	1.25		1.00		0.00		2.00	
Castro	24	6	1	7		6		4		0.15	0.06	0.29	0.00	0.00		0.00		0.00		0.47	0.67	0.00	0.43		0.00		1.25	
Svenson	12	2	1	3		5	2	1		0.38	0.00	0.00	0.00	0.00		0.00	0.00	0.00		1.86	1.00	0.00	1.00		0.67	1.50	7.00	
Lages	34	8		11	1	12		1	1	0.22	0.05	0.00		0.00	0.00	0.32		0.00	0.00	0.75	1.00		0.40	1.00	0.08		1.00	1.00
Borsoi	22	6	1	3		10		1	1	0.10	0.02	0.00	0.00	0.00		0.13		0.00	0.00	0.64	0.50	0.00	0.33		0.00		1.00	2.00
Claudio	26	8	3	3		9		2	1	0.10	0.00	0.00	0.00	0.00		0.00		0.00	0.00	0.57	0.50	0.00	0.33		0.11		1.00	1.50
Mean	20.50	5.57	1.67	3.14	1.33	8.64	2.00	1.79	1.00	0.16	0.01	0.09	0.00	0.00	0.00	0.05	0.00	0.00	0.00	1.10	0.72	0.00	0.65	1.33	0.11	1.50	1.88	1.50
Sample																												
Mean	20.95	6.15	1.67	3.55	1.33	9.05	2.00	1.79	1.00	0.16	0.03	0.08	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.70	0.64	0.00	0.59	1.33	0.17	1.50	1.88	1.50

6.3.2. *The structure of the houses*

Figures 6.9. to 6.11. plot the respective RC and DP value for each sector of the colonial, eclectic and modern samples. The 'sectors' boxes' characterise the structure of the houses form the point of view of the composition of their sectors.

The colonial sample is relatively homogeneous in the form in which their sectors are structured. In all, but two cases (houses C6 and C14), the colonial houses are absolutely tree-like. Also, the sectors of each house tend to present similar RC values. For example, houses C2, C3, C6, C12 and C11, are composed by sectors which are either within or below the 'transitional area', limited by the DP values 0.50 and 1.00. This low differentiation between sectors' degree of permeability demonstrates the relative homogeneity of the structure of the colonial sectors.

The eclectic houses, on the other hand, are more heterogeneous. Their DP and RC differ more dramatically in every house. Houses E4, E12, E22, E24 and E26, present sectors with DP values well over and above the 'transitional area', but also within it. Heterogeneity is also seen in the combination of ringy and tree-like sectors in all houses, but two (houses E20 and E24). This more complex articulation of sectors is reinforced by the significant differentiation of the DP values of the ringy and tree-like sectors, the first being normally more bounded than the second. High degree of permeability is another important distinction of the eclectic houses. All dwellings present DP values which are well above 1.00, particularly houses E2 and E20 which are composed by fuzzy sectors, all above the 0.50 transitional boundary line.

The modern houses are also complex in their sectors' composition. The 'sectors' boxes' of the non-mediated modern houses (Alcoforado, Pereira, Meirelles, Marinho, Guerra and Pontual houses) are interestingly similar. Their sectors tend to have clear boundaries and be organised as trees, but when rings are present their RC values are low and close to each other. However, the similarities between the houses seem to be confined to these general properties. Indeed, the variety of RC and DP values of each individual sector in different houses proves once more, that when observed individually, houses tend to demonstrate how diverse and complex their overall structures are. For example, Alcoforado and Pereira houses have very similar graphs, but the degrees of permeability of their service and private sectors are exactly the reverse. Alcoforado encloses the private sector, whereas Pereira encloses the service sector, and vice-versa.

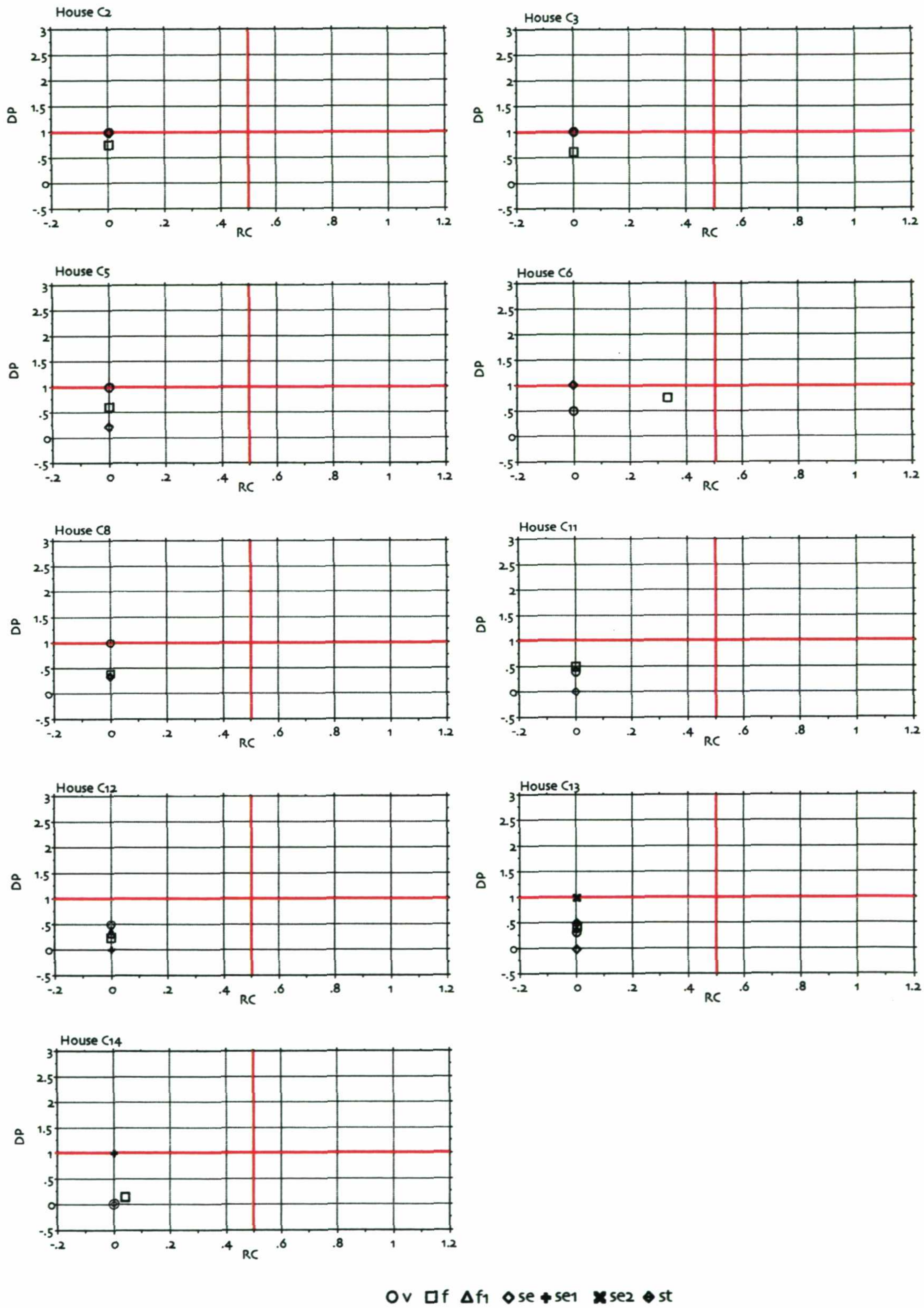


Figure 6.9. Colonial houses: the sectors' box by house

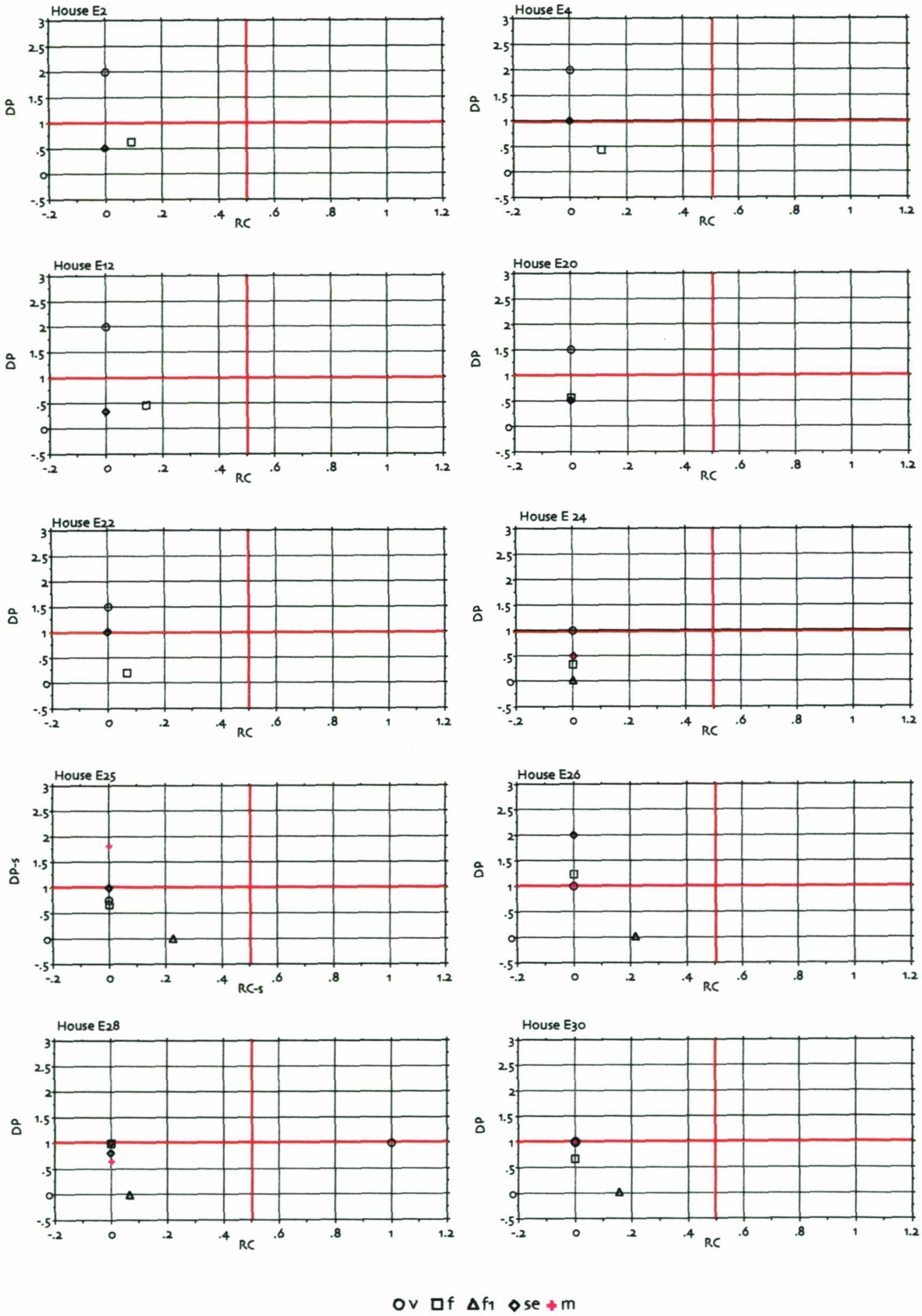


Figure 6.10. Eclectic houses: the sectors' box by house

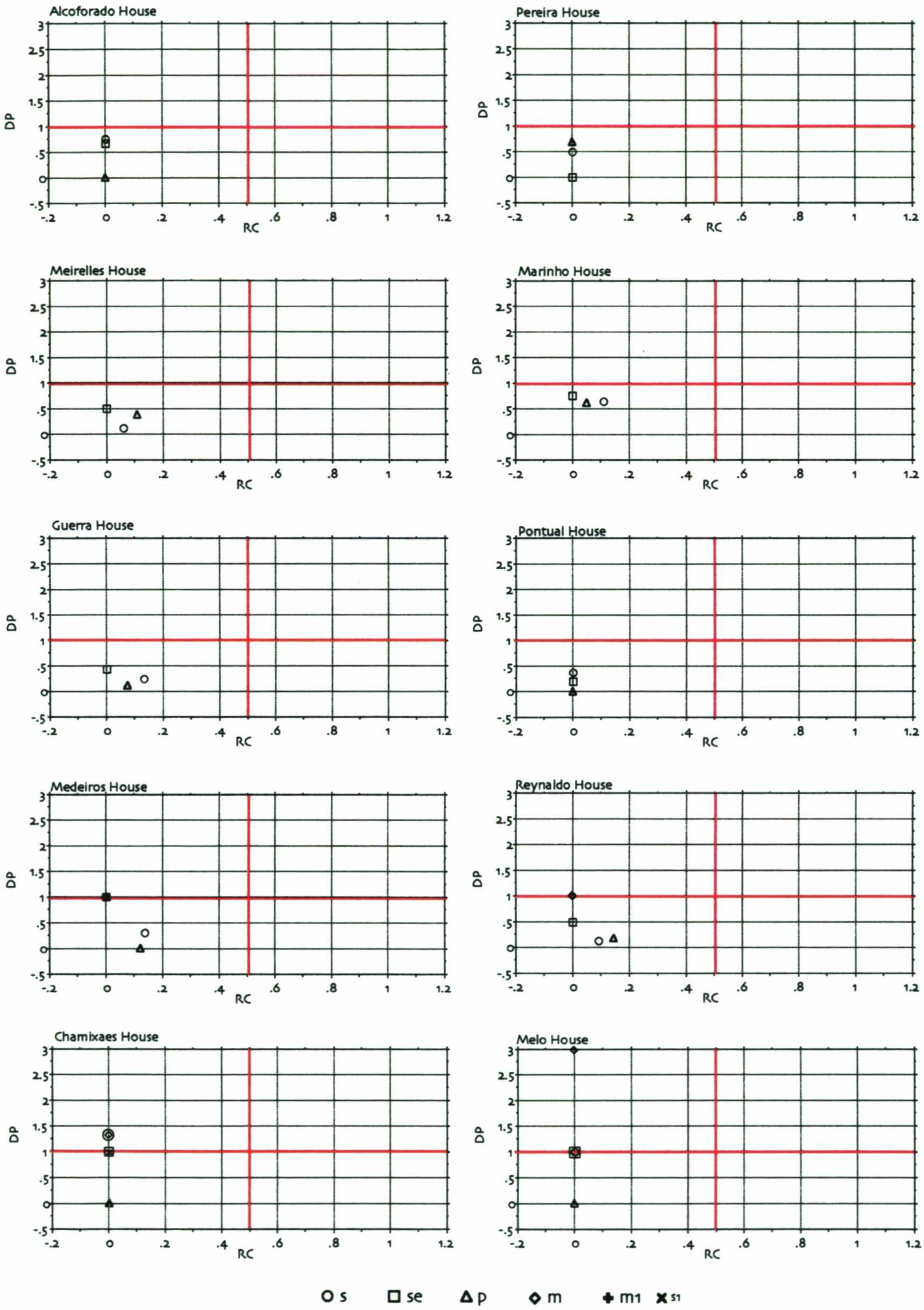


Figure 6.11. Modern houses: the sectors' box by house

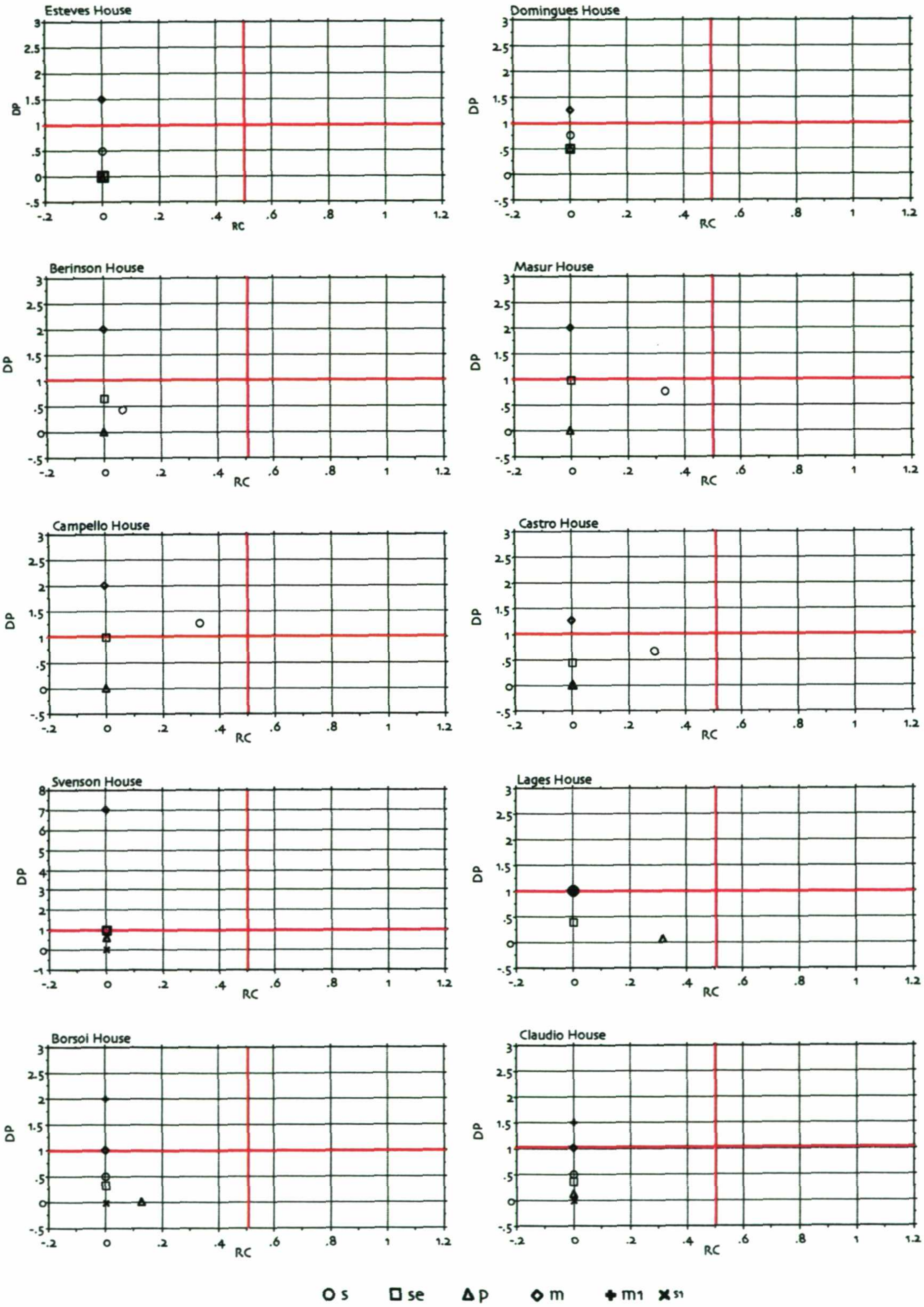


Figure 6.11. Modern houses: the sectors' box by house (continued)

The mediated houses, on the other hand, are more heterogeneous, according to the structure of their sectors. The DP and RC values range more widely, as demonstrated by the 'sectors' boxes' in figure 6.11. In some of the mediated tree-like houses, like Melo or Svenson, the boundaries of their sectors are either highly fuzzy or absolutely clear (DP=0.00), but in others, like Domingues house, all their sectors have high degrees of permeability, above the transition boundary line (0.50). This variety in the sectors' structures is also perceived when rings are introduced. Campello, Castro and Masur houses, have social sectors with a relatively high RC value, ranging from 0.29 t0 0.33, which differentiate their sectors more emphatically.

6.3.2.1. Mean DP and RC values of the houses

The composition of the houses can also be evaluated by calculating their average DP and RC values by summing up the respective values of their sectors. Figure 6.12. plots the results of each house in the three samples.

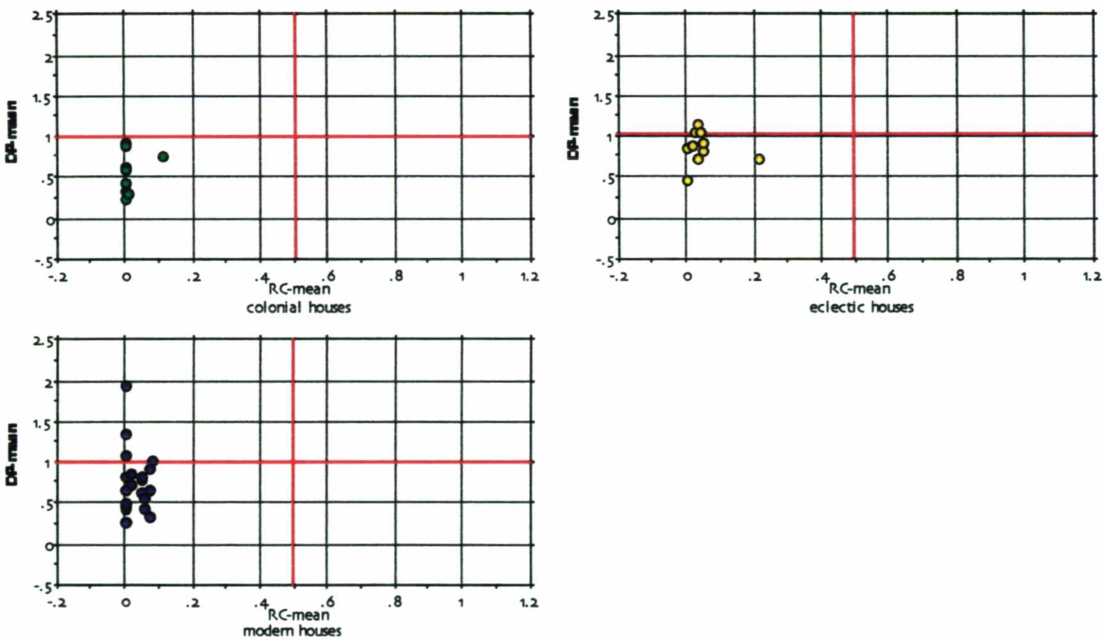


Figure 6.12. Mean DP and RC values per house in each sample

The linear colonial graph and the clustered eclectic graphs are evidences of how different the sectors of these two types of houses are structured. The graphs reinforce the argument of a homogeneous set of colonial houses. All colonial houses are included in the minus/minus quadrant and, apart from two houses, they are all composed by tree-like sectors. Houses' mean values also confirm the more heterogeneous composition of the eclectic dwellings, which assume that rings are essential for making the dwellings work. They also show that, on average, the eclectic dwellings are more open, with all houses but one included within the transitional area and above the plus/minus boundary.

Figure 6.12. also shows how heterogeneous the modern sample is, with houses composed by ringy and enclosed sectors, by tree-like and highly opened sectors, and a significant variety of cases which combines both extreme forms of structures. This diversity contrasts with the previous samples, and may be interpreted as a significant sign of the sort of architectural speculation that characterised the houses designed by architects.

6.3.3. The structure of the main domestic sectors

The average DP and RC values for the houses may be significant in describing their general structures and also to identify the particularities of each sample, but a detailed observation of the structure of their sectors may be essential to provide a more sensible picture of the particular forms assumed by the domestic sectors. This is possible by isolating the main pre-modern and modern sectors in independent 'sectors' boxes' (figure 6.13.).

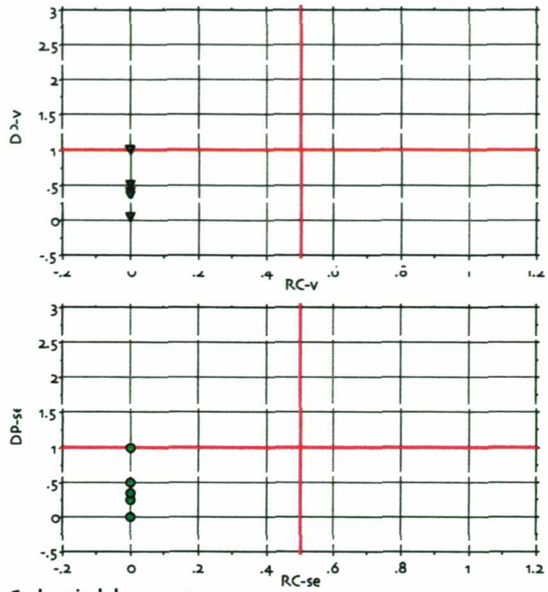
6.3.3.1. The colonial sectors

The isolation of the sectors in different graphs makes evident the similarities between the colonial visitors' and service sectors. Both are tree-like (RC=0.00) and have DP values ranging from 0.00 to 1.00, with a mean DP value of 0.64 for the visitors' and 0.45 for the service sector. Despite the relative fuzziness of some of these sectors, with values close or equal to 1.00, the majority of cases presents values equal or lower to 0.50, therefore below the 'transitional area'. This demonstrates that both sectors are susceptible to a high control of access and movement, both between sectors and also within them.

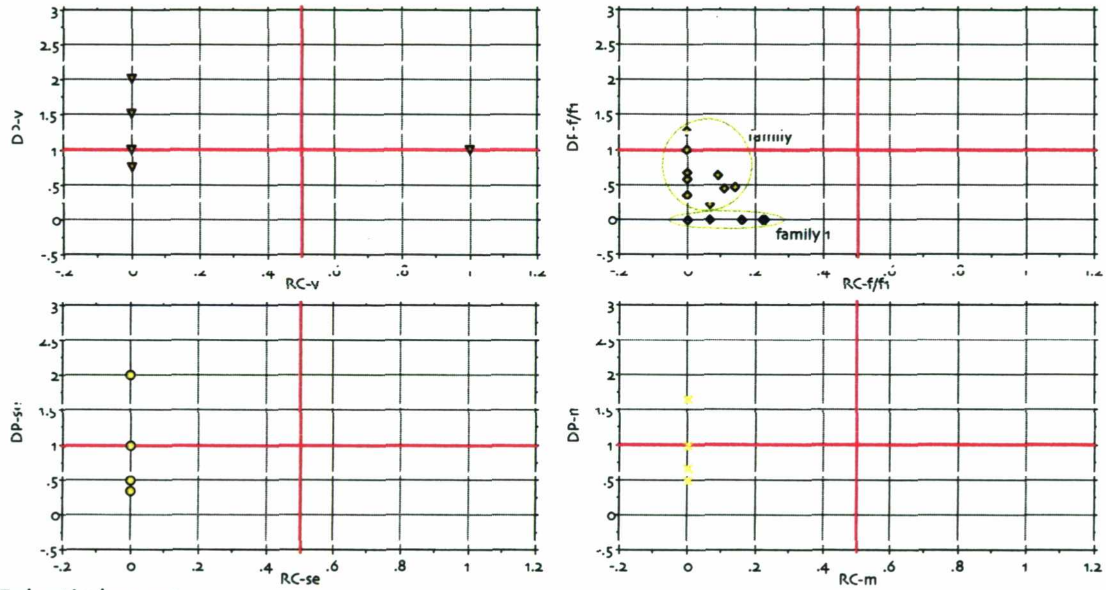
The colonial family sector is manifested in more diverse forms. It is the only colonial sector to present positive RC values, as a result of the local rings of houses C6 and C14. With regards to their degree of permeability, the family sector follows the same characteristics of their colonial counterparts. All family sectors lie in the 'minus/minus' quadrant; however, a considerable number of cases (houses C1, C3, C5, C6 and C11) stay in the transition area, demonstrating the relative fuzziness of the colonial family boundaries.

6.3.3.2. The eclectic sectors

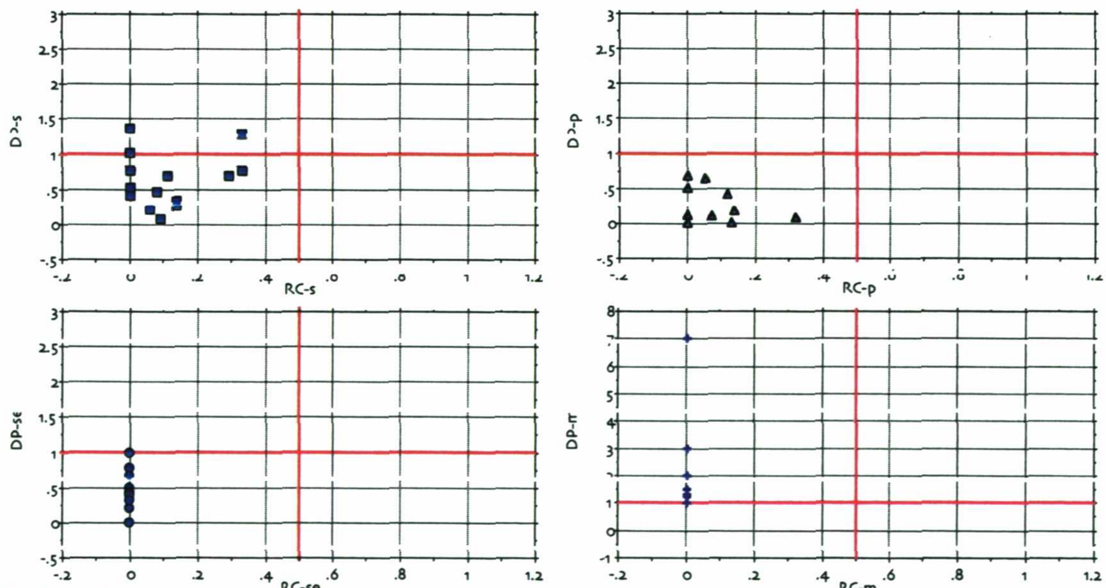
The 'sectors' box' also makes evident how the eclectic houses reshape the functional organisation of the colonial houses. The eclectic visitors' sector, albeit remaining tree-like, is more open. Nine out of ten eclectic dwellings present DP values higher than 1.00 and the remaining case (E25) has a relatively high DP value of 0.75. The openness of the eclectic visitors' sector is made possible by the approximation of receiving and dining rooms, and the



a) Colonial houses



b) Eclectic houses



c) Modern houses

Figure 6.13. The main pre-modern and modern sectors isolated in the 'sectors' box'

direct connectivity of the visitors' spaces to some bedrooms. This transformed layout, with fuzzy visitors' boundaries, was essential to allow a diachronic use of the eclectic house, adapting their layout according to the social circumstances of their use, as described in chapters four and analysed in chapter five. The fuzzy boundaries permitted the much needed flexibility of the plans by closing and opening doors, therefore expanding or reducing houses' territories, and by offering alternative accesses within and through sectors'.

The tree-like form of the visitors' sectors may be explained by their size. Eight of the houses present sectors which are composed of less than three spaces, therefore hindering the possibility of generating rings. In the remaining houses, in spite of their size (three and four convex spaces), their visitors' sectors remain without rings, with the exception of House E28, which encircles the guests' bedroom, the waiting and visitors' rooms in a local ring. In summary, the eclectic visitors' sector may be characterised as shallow and tree-like, regardless of its size.

The eclectic service sector is also, on average, larger than the colonial service sector (2.44 convex spaces against 1.66), but only two of the eclectic dwellings are composed of more than three convex units. This explains the absolute lack of service rings, but it does not justifies their absence, because even in larger sectors, rings are not found. It seems that the tree-like format of the service sector is determined by its operative or mechanical nature, which induces the location of the kitchen at its core and disperses the remaining service spaces around it. The lack of rings unifies colonial and eclectic service sectors, but the last one is more open to its adjacent spaces. The majority of the eclectic houses (60%) have fuzzy bounded service sectors, with DP values equal or higher than 1.00. This confirms the strong investment of eclectic houses in opening up sectors' boundaries in order to establish a higher degree of flexibility in space use.

The eclectic family sector is on average smaller than the colonial family sector (5.8 and 8.0 convex units respectively), due to the isolation of the bedrooms in an independent sector in the first-floor eclectic dwellings. The eclectic family sector is more open and ringy than its colonial counterpart. It has on average a DP of 0.62 and a RC of 0.08, against 0.50 and 0.04 of the colonial houses. The higher degree of ringiness of the eclectic houses is given by the existence of rings connecting the family spaces of houses E2, E4, E12 and E22.

It is important to highlight that the formalisation of a private sector in the eclectic dwellings is accompanied by the introduction of mediating spaces. The private secondary family sector, the embryo of the modern private sector, has the highest RC values of all eclectic sectors, as a result of its thoroughfare bedrooms. Its high RC values contrast with the clearness of its boundaries, clearness necessary to sustain privacy and isolation within the household complex. This clearness is also reinforced by the introduction of the mediator sectors which buffer the interference of other domestic activities with the reserved sector. The eclectic mediator sector is relatively small (2.60 convex spaces on average), consequently it has reduced RC values. The lack of rings is compensated by their high DP values (average of 0.97), found to be above the transitional limit (0.50).

6.3.3.3. The modern sectors

However, mediation is a typical characteristic of the modern houses. It is pervasively present in the modern dwellings, controlling access from sector to sector and preventing undesirable encounters. The high connectivity of the mediator sector is perhaps its main characteristic. As its main function is to serve as a buffer zone between sectors, its boundaries must be as fluid as possible (which does not mean that they may be lockable). All modern mediator spaces (including the secondary one) have DP values higher than one, presenting the highest average DP value of all sectors (1.88). Svenson (M154) and Melo (M68) houses have the highest DP values of both pre-modern and modern sub-samples, 7.00 and 3.00, respectively.

The eclectic mediator sector present similar properties to the modern mediator sector, albeit having lower DP values. This indicates that some sectors keep their structures intact through time, regardless of the changes which have occurred in the general composition of their layouts and in the way the houses are sectored.

The modern service sector has on average 3.55 convex spaces. Eleven out of the twenty houses analysed are composed of more than three convex spaces, but despite their size, they are organised as tree-like structures, reproducing the colonial and eclectic models. This confirms that the lack of rings is not a consequence of the size of the service sector, but of its operative nature. It also expresses the consistency by which this operative sector is spatialised regardless of the profound changes occurring in the domestic environment, both in its functional and formal elaboration. The tree-like form of the service sector is indeed a common link between pre-modern and modern houses, but modernity idealised fuzzier boundaries. Six modern dwellings have DP values equal to 1.00. This increase of the DP values seems to be, paradoxically, a consequence of the introduction and proliferation of mediator sectors in the modern dwellings. This can be evaluated by observing the average DP values for the mediated modern houses, which is 0.65, and the non-mediated houses, 0.43.

This paradox has a simple explanation. What mediation does in some of the typical modern layouts is to establish alternative routes from/to the service sector, adding another access to the direct connection between dining and kitchen. The addition of alternative accesses to social and private areas produce more permeable service sectors. Marinho, Masur and Lages houses exemplify this phenomenon.

Modern private and social sectors are the only modern sectors to present internal rings. This morphological property confirms that spaces for communal use and for individual privacy are the only classes of spaces to be interconnected through rings, even though less frequently. Only nine houses have social rings and seven have private rings, with RC values ranging from 0.06 to 0.33, and 0.05 to 0.32, for the social and private sectors respectively. The mean RC values show that, on average, both sectors are arranged as trees.

Offering alternative choices of movement in communal and individual spaces, however, has opposing aims. In the pre-modern family and in the modern social sectors, rings are introduced to integrate receiving and living activities and to generate a more lively and informal atmosphere, whereas in the private sectors, the intention of generating rings is to increase the control and surveillance of parents over their children.

If the existence of rings unifies social and private sectors, the characteristics of their boundaries could not be more different. The private sector has the clearest boundaries of all modern sectors, as their low mean DP value attest (0.11). Only four dwellings present DP values equal or higher than 0.5, two non-mediated (Pereira and Marinho houses) and two mediated houses (Domingues and Svenson). The clearness of the boundaries accounts for the need to generate the much praised individual privacy, obviously stronger in the mediated modern dwellings than in the non-mediated ones, as their DP values attest (0.30 and 0.11, respectively). It seems that the evolution from the eclectic secondary family sector to the formalisation of the modern private sector was made by reinforcing the isolation of the individual cells, therefore the reduction of the mean RC values of the modern houses, and by the establishment of the mediator sector as the spatial means of control of access and isolation of the private sector.

Spaces for entertaining guests changed more significantly. The average size of the modern social sector is higher (6.15 convex units) than the colonial and eclectic visitors' sectors (3.78 and 1.90, respectively). This is perhaps one of the reasons why the modern social sector is more bounded than its preview versions, because the likelihood of opening up the boundaries of all its spaces is small. The average DP value for the modern social sector is 0.64, whereas the same value for the colonial houses is 0.69 and for the eclectic houses is 1.39. Despite presenting the lowest DP values amongst the sectors dedicated for entertaining guests. Only six of the modern dwellings have values below 0.5, and twelve houses have social sectors which are within the 'transitional area'. In summary, spaces for entertaining guests evolved to assume a more ringy and less fuzzy composition.

6.3.4. The typical houses and their typical sectors

6.3.4.1. The typical sectors

One method to visualise and evaluate the differences between the various forms that domestic sectors assumed through time is by comparing their typical profiles. Figure 6.14. compares the structures of the pre-modern and modern sectors which develop similar kinds of domestic activities or accommodates similar classes of users, by plotting their mean DP and RC for the samples in the 'sectors' box'. The graphs are presented in an enlarged scale, zooming into the minus-minus and minus-plus quadrants.

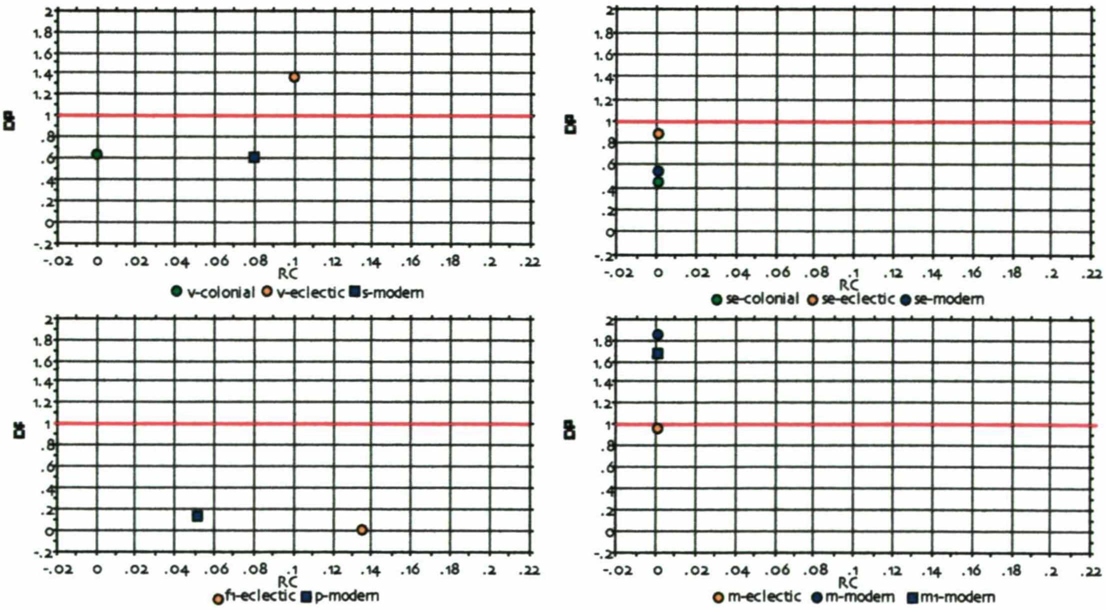


Figure 6.14. The typical pre-modern and modern sectors

What the figure clearly shows is how significantly different the eclectic sectors are and how the modern sectors somehow establish themselves in a intermediate position between the colonial and eclectic sectors. It expresses the transitionality of the eclectic houses in exploring new forms of spatial organisation and the final sedimentation of a new referential model for the modern dwellings.

Indeed, if one wishes to trace how these domestic sectors evolved, figure 6.14. draws the fundamental lines. Receiving areas changed from the controlled tree-like model to assume an open and ringy format within the eclectic dwellings, however, with its boundaries highly controlled by closing and opening doors. Modernity abdicates the use of these physical boundaries by reducing fuzziness and ringiness to a level in which space itself would handle the need for privacy and sociality in the domestic ambience. Therefore the usefulness of the mediator sector which was introduced by the eclectic dwellings but has its potential as a buffer and connector is only fully explored among the modern houses. Service spaces kept the tree-like form as its basic model, but altered their relations with the adjacent spaces from the colonial closeness to the eclectic openness, but modernity readjusted their position just above the 'transition line' (0.50) establishing the parameters for a functional and isolated modern service zone. Individual privacy is conquered by the eclectic dwellings and its proposed form is yet to provide a full privacy, because of the thoroughfare bedrooms. Full individual privacy is finally achieved with the drastic reduction of internal rings and the formalisation of the a-type cell as the paradigm for the configuration of the modern bedroom.

6.3.4.2. The typical houses

This evolutionary picture may be completed by observing how these typical sectors were combined. The graphs presented in figure 6.15. give a general picture of each sample with regard to the way their sectors are organised. They represent what would be the typical colonial, eclectic and modern houses.

The typical colonial house is made of tree-like sectors, apart from occasional local rings in the family sector. The different territories of the house are demarcated by clear boundaries. The fuzziest colonial sectors are the family and the visitors' ones; they both lie within the 'transitional area', but none of the main sectors has values higher than one.

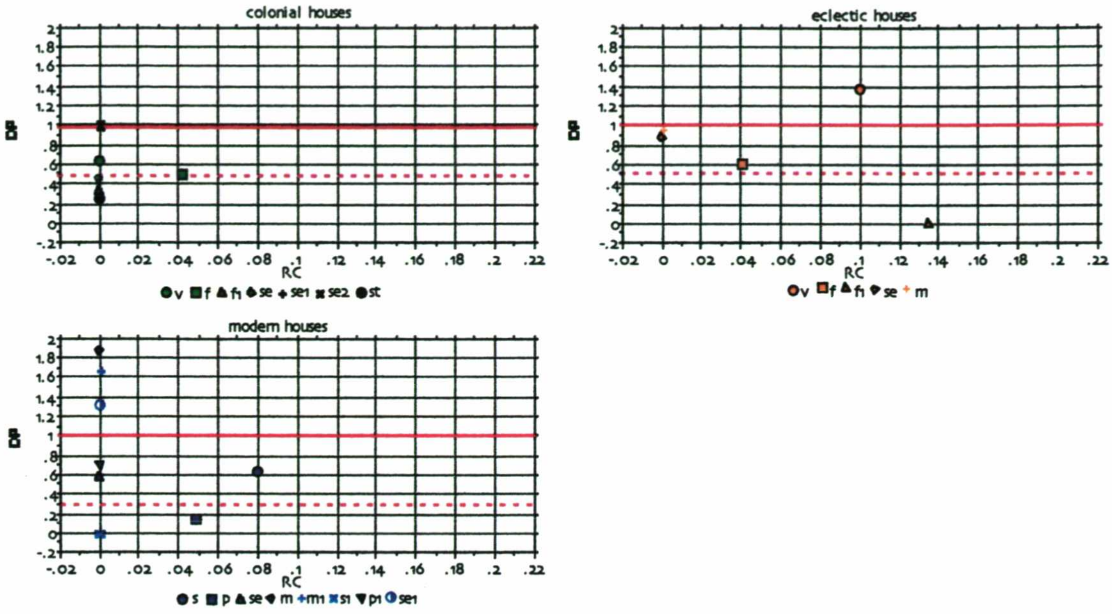


Figure 6.15. The typical houses

The typical eclectic house is more heterogeneous in the structure of their sectors, than the typical colonial house, due to the introduction of rings within the sectors. Indeed, one may find fuzzy bounded and ringy sectors, but also clearly bounded and tree-like ones. Ringiness is more expressed in the visitors' and secondary family sectors, whereas fuzziness is more evident in the visitors' sectors, but also significant in the service and family sectors.

Finally, the typical modern house is composed of operative tree-like sectors (service and mediator) and occupational ringy sectors (social and private). Fuzzy boundaries are only found amongst mediator sectors. Fuzziness depends on the functional articulation of the system and not on the integration between the sectors.

Within these general models, two sub-models may also be described, formed by the non-mediated and mediated housing types. The typical non-mediated eclectic house is particular by its use of rings in the family sector, whereas the mediated one is individual by the complexity of its visitors' and secondary family (private) sectors. Perhaps the reason why mediated and non-mediated houses arrange their main sectors differently lies in the social status of their owners. As the mediated houses are occupied by the high ranks of society, the spatial complexity of their visitors' sectors are explained by the sophistication of the social activities that are seen in these houses. Reversibly, more modest houses invest in the spatial organisation of their family sectors.

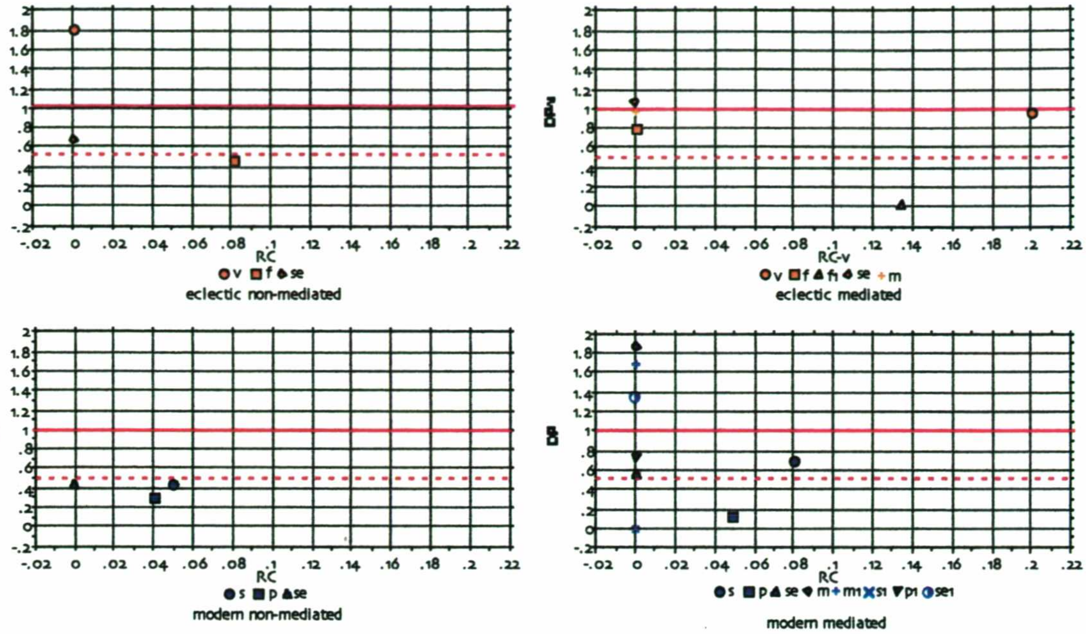


Figure 6.16. The typical mediated and non-mediated eclectic and modern houses

The typical non-mediated modern house is particular in the openness of the boundaries of its private sector, consequence of its liberation from the control of the mediator sector. The mediated type, on the other hand, individualises itself by investing in rings and in the fuzziness of the social sector. However, one common property of all these typical dwellings is their tree-like configurations. They not only explore tree-like structures in the internal organisation of their sectors, but in their overall forms as well. This endorses Hanson's remarks that 'as evidences accumulates, it is becoming apparent that houses in many parts of the word exploit tree-like configurations to organise domestic space, though this is by no means universal' (Hanson, 1998: 272).

Indeed, pre-modern and modern dwellings of Recife present very low RC values (figure 6.17). The colonial houses contain the less number of rings amongst the samples. If 'tree-like homes share the property that movement about the interior and in relation to the exterior is highly controlled and predictable from the layout' (Hanson, 1998: 272), then the colonial houses are nothing more than a proof of evidence of the strict patriarchal society which forged their forms.

The changes at Recife's society which occurred in the turn of the century reformulated the 'colonial trees' with the increase of rings in their layouts. The 'eclectic rings' are the sign of changes, but not necessarily of social and familial informality. Rings bring more possibilities of space use, but exercising control over the potential movement generated by the spatial configuration is yet another form of expressing social inequalities. This seems to be the case within the eclectic dwellings. As an offspring of a transitional era, the eclectic house stands out from the other samples for its high mean RC value, which is more significant amongst the eclectic non-mediated dwellings.

Modern houses re-establish the tree-like form as a model for domestic organisation, both for non-mediated and mediated houses. The 'modern trees' are less pronounced and, therefore, less rigid. They may be interpreted as being resulted from a combination of an elaborate spatial configuration which offers a certain degree of informality within the living areas and a certain degree of reservation for its private precincts. In spite of this, some houses explore the benefits of rings, as Svenson House confirms. Its mean RC of 0.38, the highest of all, expresses its exceptional case, but suggests that for some modern architects ringiness is fundamental as an exploratory spatial tool.

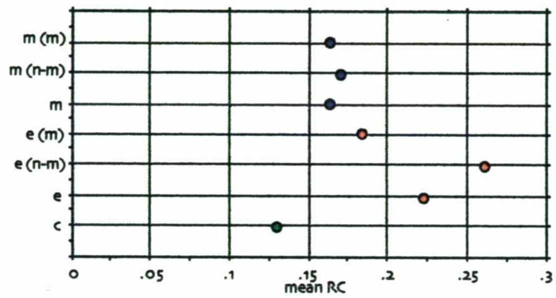


Figure 6.17. Mean RC values for the pre-modern and modern samples

6.3.5. On the evolution of the structure of the domestic sectors of Recife

The observation of the structure of the sectors give rise to some interesting findings, summarised as follows

a. Pre-modern and modern domestic sectors of Recife tend to occupy the minus/minus quadrant of the 'sectors' box', with the exception of the mediator sector, which in most of the cases is located in the minus/plus quadrant.

b. Spaces for receiving and living have adapted themselves more significantly through time, while keeping high degrees of permeability. The more significant changes occurred in their internal configuration. In the patriarchal house, visitors were guided through a tree-like system, usually of small size. The 'emancipated' eclectic dwelling introduces rings and open up its boundaries, more significantly amongst the ground-floor houses. The modern house establish itself between the two models, by keeping the fuzziness of the eclectic dwelling, but reducing the number of its internal rings.

c. Mediator and service sectors present a strong diachronic stability in their design. The rare exceptions identified in the samples results from the variation on the fuzziness of their boundaries, but their tree-like nature is kept intact.

d. Mediation is more effective and central in modern than in eclectic dwellings. This is clear in the increase of the DP values of the modern sectors due to the connectivity to the mediator sector

e. Privacy is slowly reinforced from the colonial communal family sector to the emergent ringy eclectic secondary family sector, to the clear bounded and tree-like modern private sector

In summary, it may be said that the colonial houses are more rigidly programmed, in a sense that their sectors have the clearest boundaries of the samples, and they are symmetrically arranged in tree-like forms. The eclectic dwellings form a distinct set for their high degree of permeability and relative connectivity. As a transition between patriarchy and the modern family, the eclectic dwellings seem to propose a layout in which flexibility would permit the survival of some aspects of the patriarch domestic model, but also would allow for more open forms of space occupation.

The modern dwellings establish a third model, which is neither as programmed as the colonial, nor as unprogrammed and flexible as the eclectic dwelling. The social sector, being fuzzy and ringy, provides higher chance of encounters, because its boundaries are more relaxed, and therefore, there is more flexibility in its use. Movement through the service sector is highly controlled, but its boundaries are relatively opened due to its operative role in the house. The private sector tends to have clear boundaries, therefore access is controlled and isolated from the rest of the system. Movement inside the sector is also highly controlled, indicating that its use is highly programmed to isolate individuals in cells. Finally, the mediator sector is the potential place for encounters, as its boundaries are opened towards the other sectors.

6.4. Final remarks

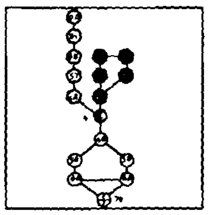
This chapter has developed a diachronic comparison of the pre-modern and modern dwellings of Recife, observing both the form in which they are sectored and the spatial structure of their sectors. The results of the analysis of these two levels reaches very similar conclusions regarding the evolutionary transformation of the Recife's domestic ambience. They both point to the stable form by which the service rooms were spatially handled through time, being perhaps the most consistent characteristic of the type of domestic organisation generated by this particular culture. They also demonstrated that even though there were changes to the form in which classes of activities and users were sectored in pre-modern and modern houses, the conceptual centrality of the spaces for receiving guests remained unaltered.

But most importantly, the study revealed that the passage from the colonial to the modern way of living established a new form of space-social relations. In the pre-modern dwellings, built in a period in which codes of behaviour and strong social inequalities pervaded, the isolation between domestic sectors were socially handled. In other words, in a society in which oppression and control were the rule and not the exception, the establishment of functional territories in the domestic environment was primarily formulated by means of social rules. Space was subservient to these rules, in such a way to allow for diachronic changes in their configuration.

In the modern dwellings, these strong social rules where relaxed. In this sense, the necessary isolation between the domestic territories had to be established or constructed spatially, rather than socially. It is space that constructs barriers in this more open household. It is by fixing topological distances, like 'my bedroom is upstairs', or the 'kitchen is at the rear end', or even, 'the bathroom is beyond the corridor', that territories are fixed. The doors which were used to prevent the guests from moving and seeing deep inside the houses is now substituted by subtle spatial movements which make access difficult, while exposing to the view most parts of the domestic interior.

On the other hand, modern houses reinforce some requirements of a functional nature, establishing fixed relationships of space-use, therefore being less flexible to changes in the spatial configuration of buildings. Modern houses, by fixing more strongly functional values into spatial configuration, turn dwellings into synchronic oriented systems rather than becoming diachronically adaptable. Ironically, the very much mentioned flexibility of modern plans has not fully materialised in Recife's houses. Indeed, space flexibility seems to constitute one of the many myths which surround modern buildings.

Chapter Seven
On How the Sectors' Paradigm Guides the Configuration of The Houses of Recife



So far, this investigation has mapped the various types of domestic activities in space and identified how they are consistently grouped into social-functional sectors. It has shown that these sectors are organised into phenotypical arrangements and manifested in consistent genotypical forms. It has also attempted to construct a typology of these sectors according to their extrinsic properties, i.e., how the sectors are internally configured and how they are related to each other.

The overall result of the analysis suggests that the way these sectors are spatialised, either by building clear or fuzzy boundaries by having sectors with low or high external connectivity, or by reducing or increasing the choices of movement inside them, may interfere in the overall pattern of integration of the dwellings. After all, if the sectors are fundamental in housing design because they define the adjacent and permeable form of the houses, then they must have an active role in the constitution of houses' configuration. How does this take place?

The first step to answer this question is to understand three basic principles of spatial configuration. Configuration is understood as relations in a complex which takes into account all other existing relations in the same complex. Therefore, the properties of the whole complex are created on the basis of local relations, and vice-versa. This defines the first and one of the most fundamental principles of configurational systems, which says that the structural properties of the whole are likely to alter when its parts arechanged. For example, the overall depth of a system may be drastically altered by simple local changes, as demonstrated in figure 7.1. By cutting one connection of the highlighted space, the total depth of the system is increased from 80 to 92, whereas by adding a connection to the same space, the total depth of the system is reduced to 74.

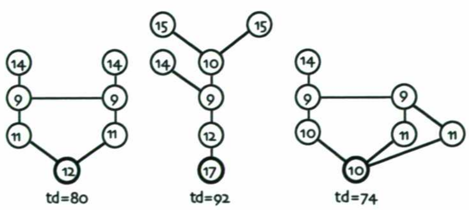


Figure 7.1. Configurations

Moreover, these changes are likely to be felt by each unit of the system. When one of the connections is cut, the whole system becomes shallow from the highlighted space but some spaces retain their structural properties. This is important because it demonstrates the second configurational principle, which says that the whole is differently seen from each of its spatial units. This is why changing the topological characteristics of a space is more efficient in creating substantial alterations in the whole configuration than changing other spaces in the same configuration. This is also why spaces with different structural properties are likely to be used for different purposes, as demonstrated in a variety of syntactic studies (Hillier and Hanson, 1984; Hillier, 1996; Hanson, 1998).

However, the consequences of these structural changes are very difficult to predict (Hillier, 1999: pp 35.11-35.16). The effect of a change is only completely understood when the whole configuration is analysed from the point of view of each of its component units, i.e., by justifying the graph from each space and counting the distance from each space to all the other spaces. This third principle explains why graphs are theoretically difficult to predict.

These three principles suggest that the sectors' organisation may have little or no effect in configuring whole systems, as the space-to-space permeability process would primarily act to shape the configuration of the whole. However, if the spatial units are organised in meso-spatial-structures, or spatio-functional sectors, the relative position and permeability of each space is defined by the 'rules' which have structured the sectors themselves. Therefore, it is possible that the structure of the sectors affects the way local changes generate global changes. Perhaps the nature of these sectors - if ringy or tree-like, if clear or fuzzy bounded, may determine if local changes would be significant or trivial. In other words, these meso-structures may create a sort of local stability while isolating or minimising the effects of local changes in the global depth pattern, and turning the unpredictable graph into a more reliable and 'domesticated animal'.

To clarify this problem, let us describe the sectors' organisation and configurational properties of two modern residences. Figure 7.2. shows the justified graphs of Esteves and Campello houses studied in chapter 2.[35] The dwellings are represented in their minimal living complex. The justified graphs are rooted from a carrier space and each domestic sector is highlighted

35 The plans and convex maps of the houses are shown in figure 6.8.

accordingly. In Campello House, the enclosed patio is represented as a 'secondary' carrier space.

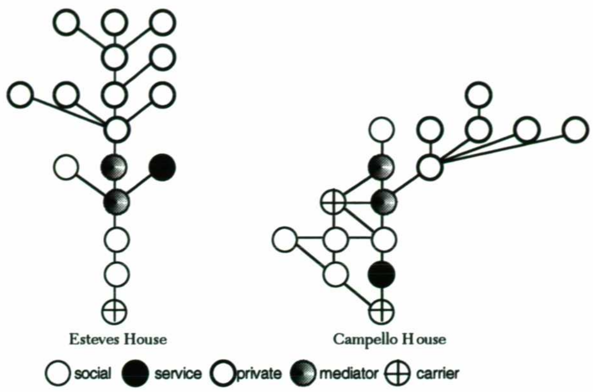


Figure 7.2. Justified graphs of Esteves and Campello houses.

The houses present some similarities in their topologies, but also some important differences. Esteves House has tree-like and clear bounded sectors, whereas Campello House has a ringy social sector and a bushy private sector. Campello House is ringy, while Esteves House is a deep tree. The mediator sectors are deep from the public space in both houses. In Esteves House the mediator sector binds all sectors together, whereas in Campello House it only separates the social and private sectors.

These different configurations can be measured. Figure 7.3. presents the total depth values for each convex space, as well as the total depth per sector.[36] In Campello House, the mediator sector, composed of two transitional spaces, draws integration towards itself. Its spatial units are amongst the most integrated spaces, followed by the spaces situated at its boundaries. The most integrated space is the internal corridor, followed by the dining room and the internal patio (figure 6.8.). The mean depth values indicate the relative position of each sector in relation to the others. In Campello House, the private sector is the most segregated of all. It is followed by the service and social sectors, the mediator sector being the most integrated of all. Esteves House also presents a highly integrated mediator sector, but the most integrated space is situated in the private sector, one step away from the mediator sector. In spite of this result, the mediator sector is the most integrated sector of the house, followed by the private, service and social sectors, respectively.

36 Total depth is used instead of the relativised integration (RRA) for two reasons. Firstly, because it allows for an easier visualisation of the differences within each house, and secondly, because there is no interest in comparing the values for different dwellings,

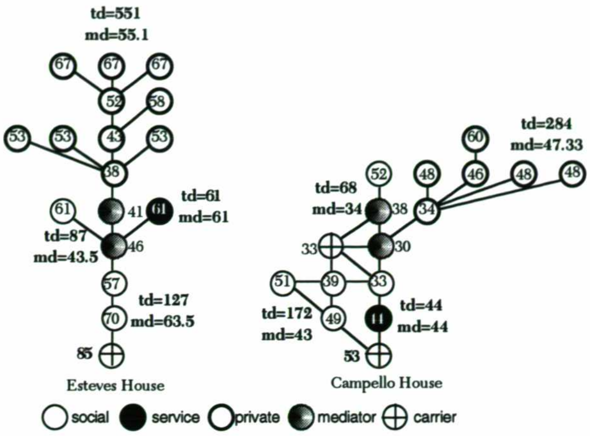


Figure 7.3. Esteves and Campello Houses: justified graphs with total depth values

These two dwellings, albeit different in size and configuration, present similar properties. For example, the carrier space is amongst the most segregated spaces and the mediator spaces are amongst the most integrated ones. But they also present significant differences. The private spaces are either highly segregated (Campello house) or highly integrated (Esteves House). Social spaces also range from the highest to the lowest ranks of integration.

These aspects are also pictured by the average depth value per sector. These values demonstrate how mediation is effective in concentrating integration, since the mediator sector is the most integrated sector in both houses. The private sector is the most integrated functional sector in Esteves House, but the most segregated in Campello House; whereas the social sector is the most integrated functional sector in Campello House, but the most segregated one in Esteves House.

Are these configurational properties somehow illustrative of the effects of the sectors organisation in dwellings' depth pattern? Are the houses always organised in order to be topologically centred around the mediator sector, thus allowing short and protected journeys from/to different sectors of the house? How are the inequalities between sectors built up? Are they a function of the internal organisation of the sectors or defined by the form which the whole complex is structured? Can these properties be taken as generic consequences of the organisation of buildings into different and ordered spatial-functional sectors? In a single question, how does the sectors' organisation influence the pattern of integration of the houses?

This chapter tries to answer these questions. It does so by developing, in sections 7.1. and 7.2., a theoretical experiment which simulates various sectors' arrangements in hypothetical buildings and by assessing their effects in the overall pattern of integration of the building. The morphological simulations consist of introducing local changes to a given sectored building and mapping the effect of these changes in its global pattern of integration. It is expected that the observation of the 'flow of integration' from space to space every time a change is made can make some suggestions on how different sectors' arrangements interfere in the configuration of buildings. Hence, the study looks at both, change and stability in the spatial system. The results of the experiments, summarised in section 7.3., are used as a framework for observing how integration is distributed in a sub-sample of modernist dwellings (section 7.4.). The chapter concludes, in section 7.5., by drawing some general conclusions on the effects of sectoring in the pattern of integration of the houses.

7.1. Experimenting with sectors

To develop this morphological experiment, a hypothetical building is constructed (figure 7.4.). It is composed of three different sectors, each of them representative of the typologies devised in the previous chapter (ringy or tree-like, closed or opened) and rooted from a carrier space. Sector 1 (thick circle) is tree-like and clearly bounded; sector 2 (black nodes) is a ring with a clear boundary; and sector 3 (thin circle) is ringy and fuzzy bounded. The sectors have the same size, five nodes, in order to distribute evenly the effects of the changes introduced to each sector and to produce a relative intense degree of ringiness and depth. Although this equilibrium between sectors' sizes is not common in real buildings, this balance is required to evaluate how depth is distributed amongst the spaces and sectors. For the same reason, the building itself is composed in order to create a relative symmetry in the system. For example, sectors 1 and 2 are situated at the same depth from the carrier space and sector 1 is positioned at the centre of the system.

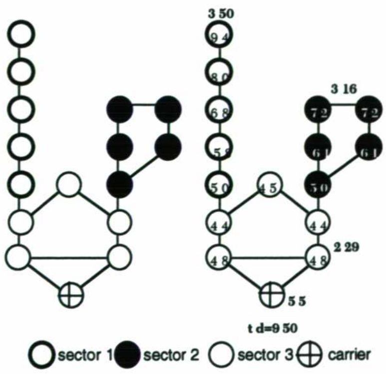


Figure 7.4. Justified graph of a hypothetical building

In this hypothetical spatial system, the sectors are directly connected to each other without any sort of mediation, as seen in many modern houses. Mediation will be introduced in a second set of morphological experiments, described in section 7.2. This is because the effect of mediation in configuring the system is better understood when compared with a non-mediated system.

The experiment is developed in three stages. The first stage changes the internal arrangements of each sector. It reduces distances amongst the spaces of each sector, either by increasing connectivity in sectors 2 and 3, or by reducing the mean depth of sector 1. The second stage keeps the internal structure of the sectors fixed but increases the number of links between the sectors, i.e., it 'melts' their boundaries. The third, and final stage, 'melts' the boundaries between each sector and the carrier space.

The experiment follows rigid rules. The changes are generated by reducing depth one step at a time, unless changes in the configuration are only generated by reducing by more than one step. The alterations introduced in each step try to reproduce, to a limited extent, the sectors' configurations seen in the sample and aims at understanding how local changes introduced in each sector affect the overall topological distances from each space to all spaces. The changes are measured by the total depth gained or lost by space and by sector and the results are compared to the values of the original arrangement. The analysis were developed with the help of the computer software NetBox, version 1.0d1 (Dalton, 1990c) and the results are summarised in table 7.1. Figure 7.5. plots the total depth loss by each sector in each experiment.

In the original arrangement of the hypothetical building (figure 7.4.), sector 1 is the deepest one, with total depth of 350, followed by sector 2 (316) and sector 3 (229). The shallowest spaces are situated in sector 3 at the boundary of sectors 1 and 2, with total depth of 44. Sectors 2 and 3 present a curious symmetric distribution of depth values. It is worth observing how this symmetry is affected when changes are introduced to the system.

Table 7.1. Results of the experiment: the non-mediated building

Experiment 1								
Changing the internal structures								
Hypothetical		C	Sector1		Sector2		Sector3	
building	sum	td	td	m	td	m	td	m
	950	55	350	70.0	316	63.2	229	45.8
Sector1								
Step 1	926	54	335	67.0	313	62.6	224	44.8
Step 2	858	51	302	60.4	296	59.2	209	41.8
Step 3	836	50	291	58.2	291	58.2	204	40.8
Step 4	810	49	276	55.2	286	57.2	199	39.8
depth loss	140	6	74	14.8	30	6.0	30	6.0
Sector 2								
Step 1	948	55	350	70.0	314	62.8	229	45.8
Step 2	946	55	350	70.0	312	62.4	229	45.8
Step 3	922	54	345	69.0	299	59.8	224	44.8
depth loss	23	1	5	1.0	17	3.4	5	1.0
Sector 3								
Step 1	946	54	350	70.0	316	63.2	226	45.2
Step 2	944	54	350	70.0	316	63.2	224	44.8
Step 3	872	54	320	64.0	286	57.2	212	42.4
depth loss	78	1	30	6.0	30	6	17	3.4
Experiment 2								
Melting the boundaries								
Hypothetical		C	Sector1		Sector2		Sector3	
building	sum	td	td	m	td	m	td	m
	950	55	350	70.0	316	63.2	229	45.8
Sector 1/ Sector 2								
Step 1	780	55	270	54.0	236	47.2	219	43.8
Step 2	740	55	250	50.0	216	43.2	219	43.8
Step 3	690	55	225	45.0	197	39.4	213	42.6
Step 4	668	55	214	42.8	186	37.2	213	42.6
Step 5	652	54	206	41.2	182	36.4	210	42.0
depth loss	298	1	144	28.8	134	26.8	19	3.8
Sector 2 / Sector 3								
Step 1	896	50	340	68.0	289	57.8	217	43.4
Step 2	832	48	320	64.0	257	51.4	207	41.4
Step 3	800	48	310	62.0	241	48.2	201	40.2
Step 4	776	48	300	60.0	229	45.8	199	39.8
depth loss	194	7	50	10	87	17.4	30	6
Sector 1/Sector 3								
Step 1	856	47	302	60.4	298	59.6	209	41.8
Step 2	802	44	298	59.6	266	53.2	194	38.8
Step 3	712	44	231	46.2	256	51.2	181	36.2
Step 4	682	43	216	43.2	246	49.2	177	35.4
depth loss	268	12	134	26.8	70	14.0	52	10.4
Experiment 3								
Connecting to the carrier								
Hypothetical		C	Sector 1		Sector 2		Sector 3	
building	sum	td	td	m	td	m	td	m
Basic	950	55	350	70.0	316	63.2	229	45.8
Sector 1								
Step 1	920	45	335	67.0	316	63.2	224	44.8
Step 2	848	41	299	59.8	296	59.2	212	42.4
Step 3	794	38	272	54.4	281	56.2	203	40.6
Step 4	746	36	246	49.2	271	54.2	193	38.6
Step 5	720	35	231	46.2	266	53.2	188	37.6
depth loss	230	20	119	23.8	50	10	41	8.2
Sector 2								
Step 1	940	45	350	70.0	301	60.2	244	48.8
Step 2	884	43	340	68.0	283	56.6	218	43.6
Step 3	848	41	330	66.0	265	53.0	212	42.4
Step 4	830	40	325	65.0	256	51.2	209	41.8
Step 5	812	39	320	64.0	247	49.4	206	41.2
depth loss	138	16	30	6.0	69	13.8	23	4.6
Sector 3								
Step 1	936	48	350	70.0	311	62.2	227	45.4
Step 2	924	42	345	69.0	311	62.2	226	45.2
Step 3	922	41	345	69.0	311	62.2	225	45.0
depth loss	28	14	5	1.0	5	1.0	4	0.8

c - carrier space; td - total depth; m - mean value

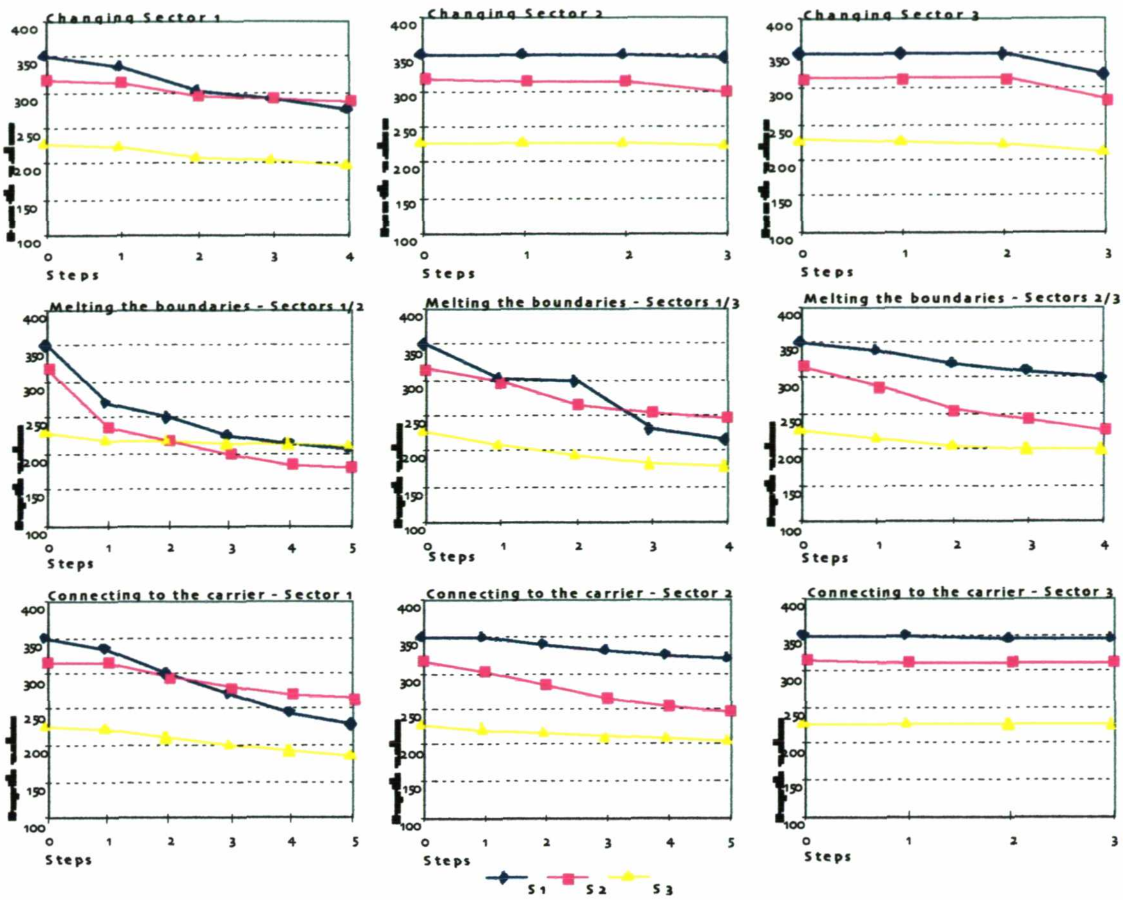


Figure 7.5. Total depth loss per sector in each experiment

7.1.1. *Experiment 1: changing the internal structure of the sectors*

The first stage changes the sectors' internal structures, but maintains their own identity, i.e., the deep-tree sector is changed to a shallow bush and the ringiness of the remaining sectors is increased (figure 7.6.). The results show that changes in the tree-like sector are more effective in reducing depth than when changes are introduced to the other sectors. This is true not only in reducing the total depth of each sector, but in the overall depth loss of the hypothetical building. The total depth loss by reducing depth in sector 1 is 140, against 23 in sector 2, and 78 in sector 3. The whole system becomes shallower when sector 1 is changed (td=810), being followed by changes in sectors 3 (td=872) and 2 (td=922).When the tree-like sector 1 is changed in order to assume the shallowest possible form, it produces a total depth loss of 30 to sectors 2 and 3, but reduces its total depth in 276 (a depth loss of 74). Increasing the ringiness of sector 3 reduces the total depth of sectors 1 and 2 in equal values (30). Changes in the deep ring and clear bounded sector 2 is the less effective method of all, generating a depth loss of 5 to sectors 1 and 3, and 17 to sector 2.

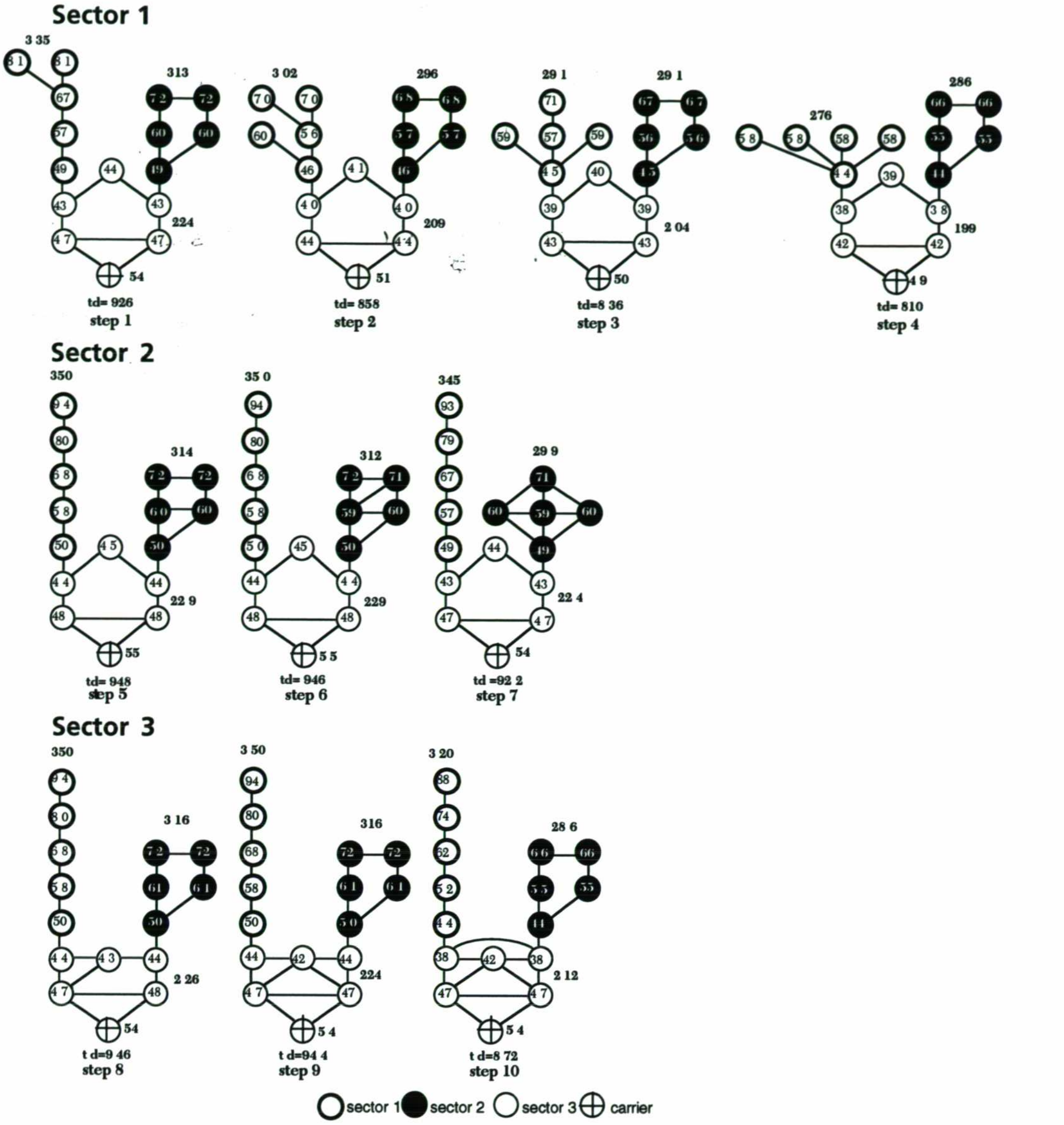


Figure 7.6. Changing the internal structure of the sectors

The evaluation of the effect of changes in the internal structure of the sectors to the relative position of the carrier space is possible by comparing the mean depth of each sector to the carrier space itself. The mean values show that the carrier is the least affected by these changes. It presents the same depth loss as the mean value for sectors 2 and 3, and 1 and 3, when changes are introduced to sectors 1 and 2, respectively. This suggests that when changes are introduced to a sector which is directly connected to the carrier, the remaining sectors and the carrier space respond similarly.

Changing the internal structure of the sectors does not move the location of the configurational core of the building. It remains in the spaces of sector 3 to which the remaining sectors are connected. They are only overcome in the order of integration in steps 8 and 9 of the changing process. But as soon as symmetry is restated, in step 10, these spaces re-assume the centre of the configuration. Perhaps the reason for this is because they are cut vertices, i.e., if one of them is removed the system would fall into two disconnected complexes (Steadman, 1983: 85). These results suggest that symmetrical systems tend to maintain its configurational core steady, regardless of the changes in the internal structures of their sectors.

The stability of the integration core is reflected in the rank order of integration of the sectors, expressed both by the average value per sector and by the inequalities of the most integrated nodes by sector, as described in table 7.2. The rank order of integration of the sectors is kept constant along the experiments, being sector 3 the most integrated of all, followed by sectors 2 and 1. This inequality is only changed in the final stages of the depth reducing process in sector 1 (steps 3 and 4), when the mean integration of the sector 1 is increased. When the most integrated nodes by sector are observed, the rank order is kept absolutely stable.

Table 7.2. Rank order of integration of the sectors: non-mediated building

Experiment 1			**Experiment 2**			**Experiment 3**		
	Mean depth by sector	Space by sector		Mean depth by sector	Space by sector		Mean depth by sector	Space by sector
System	3<2<1	3<2=1		3<2<1	3<2=1		3<2<1	3<2=1
Sector1			**Sector 1/ Sector 2**			**Sector 1**		
Step 1	3<2<1	3<2=1	Step 1	3<2<1	1=2<3	Step 1	3<2<1	3<1<2
Step 2	3<2<1	3<2=1	Step 2	2<3<1	1=2<3	Step 2	3<2<1	3<2=1
Step 3	3<2=1	3<2=1	Step 3	2<3<1	2<1<3	Step 3	3<1<2	3<2<1
Step 4	3<1<2	3<2=1	Step 4	2<3<1	2<1<3	Step 4	3<1<2	3<2<1
			Step 5	2<1<3	2<1<3	Step 5	3<1<2	3<2<1
Sector 2			**Sector 2 / Sector 3**			**Sector 2**		
Step 5	3<2<1	3<2=1	Step 6	3<2<1	3<1<2	Step 6	3<2<1	3<2<1
Step 6	3<2<1	3<2=1	Step 7	3<2<1	3<1=2	Step 7	3<2<1	3<2<1
Step 7	3<2<1	3<2=1	Step 8	3<2<1	3<1<2	Step 8	3<2<1	3<1<2
			Step 9	3<2<1	3<1=2	Step 9	3<2<1	3<1<2
						Step 10	3<2<1	3<1<2
Sector 3			**Sector 1/Sector 3**			**Sector 3**		
Step 8	3<2<1	3<2=1	Step 10	3<2<1	3<1=2	Step 11	3<2<1	3<2<1
Step 9	3<2<1	3<2=1	Step 11	3<2<1	3<1=2	Step 12	3<2<1	3<2=1
Step 10	3<2<1	3<2=1	Step 12	3<1<2	3<2<1	Step 13	3<2<1	3<2=1
			Step 13	3<1<2	3<2<1			

In fact, the most remarkable property of these graphs is the stability by which depth is distributed by sectors. When changes are introduced to individual sectors, the depth values of the remaining sectors are redistributed proportionally so that the order of integration of the spaces remains exactly the same. This result suggests that by isolating groups of spaces into defined bounded sectors, the internal configurational properties of each individual sector are preserved, regardless of changes introduced to the remaining ones.

7.1.2. Experiment 2: melting the boundaries of the sectors

At this stage, links are introduced between the sectors. The connections link the spaces which are closer to each other, in sequence, in a way that the following spaces to be linked would always be one step deeper from the previous ones (figure 7.7.).

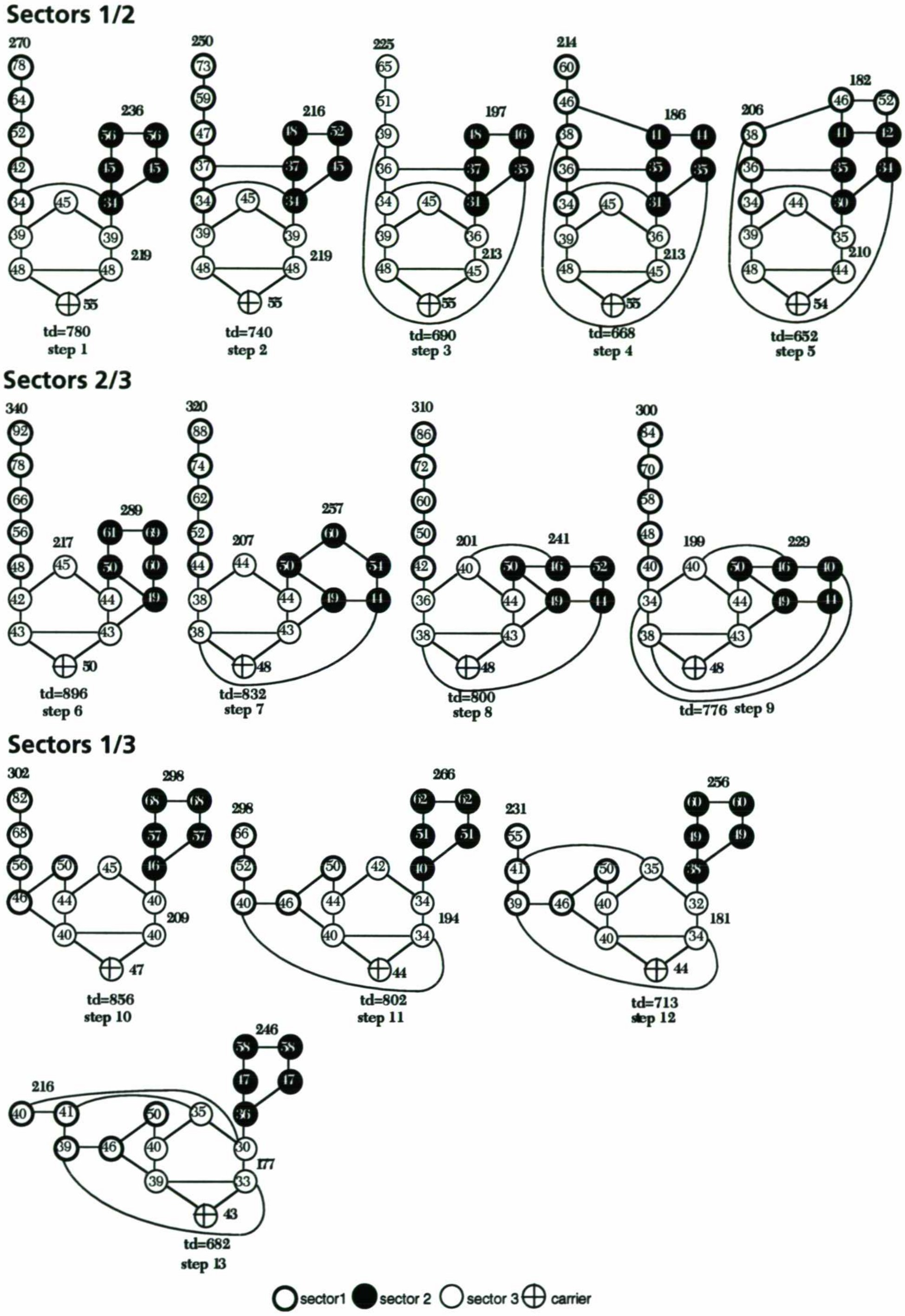


Figure 7.7. Melting the boundaries of the sectors

The maximum total depth loss is generated when the boundaries between the sectors are melted is higher than when the sectors are changed internally (298 against 140). Melting the boundary between sectors 1 and 2 generates the highest depth loss, 298, followed by the boundary between sectors 1 and 3, 268, and sectors 2 and 3, 194. Sector 1 is again the most affected by the changes, with maximum depth reduction of 144, followed by sector 2, with 134, and sector 3, with 52. These maximum reductions occur when the boundaries of the respective sectors are changed, suggesting that direct changes to sectors' boundaries are more effective in reducing their total depth, than changes introduced in other parts of the system. This is because overall distances are drastically reduced, through offering shorter routes.

Melting the boundaries also generates more depth loss for the carrier space than when the internal structures of the sectors are modified. This is because the choices of movement from the carrier space to the rest of the system is significantly increased. The exception for that occurs when the boundaries of the deepest sectors (1 and 2) are fused, given a total depth loss for the carrier of 1, against 6 when the internal structure of sector 1 is changed.

The centre of the configuration also changes. Its previous symmetric position at the boundaries of the sectors is modified in order to acquire an asymmetric balance. The most integrated spaces tend to move closer to the sector which boundary has not been melted, unless the boundaries between sectors 1 and 2 are melted, when the centre moves up to sector 2. This pattern suggests that when the boundaries between the sectors are relaxed and openness prevails, the configurational core will tend to be positioned in the space to which the remaining sector is connected.

As a consequence, the rank order of integration of the original system is more affected than in the previous experiment. When the inequalities between the sectors is assessed by the order of their most integrated spaces, the rank order shifts considerably, mainly when the boundaries between the sectors 2 and 3 are relaxed. The average value per sector gives a more stable figure, conditioned by a general rule. The most integrated sectors become the ones which their boundaries have been melted, but always keeping the ringiest sector of all as the most integrated in every step.

The intrinsic stability of the graphs is also seen in this experiment, even though deep configurational changes were added to the system. When the boundaries between sectors 2 and 3, and sectors 1 and 3 are melted, the remaining sectors, 1 and 2, keep proportional the depth distribution amongst their spaces. However, this does not occur when sectors 1 and 2 are melted. The effect of the changes on sector 3 is more difficult to predict, but yet, a general rule can be constructed. When spaces from sectors 1 and 2 which are situated at the same distance from sector 3 are connected, symmetry is preserved. However, asymmetry appears when the connected spaces are situated at different depths from sector 3. Therefore stability in the system depends on keeping a certain degree of symmetry in the graphs intact.

7.1.3. Experiment 3: connecting the sectors to the carrier

The third and final stage increases the connectivity of each sector to the carrier space. The links are also added in sequence from the shallowest to the deepest space of each sector (figure 7.8.). When sector 1 is opened up to the carrier, it provides a total depth loss of 230, which again is higher than those produced by sector 2 (138) and sector 3 (28). The reason for the reduced depth loss value generated by sector 3 is its high connectivity to the carrier.

Direct changes also generate higher depth loss to a sector. When sector 1 is connected to the carrier it has a maximum total depth loss of 119, while sector 2 has a depth loss of 69. Sector 3, however, has a higher depth loss when sector 2 is changed, with a total depth loss of 41. This is an effect of its high connectivity to the carrier space. As expected, the depth loss by the carrier space is higher than in the previous experiments. Its value exceeds the mean for each sector, unless its connectivity to sector 1 is maximised, 20 against 24.

Connecting the sectors to the carrier space brings the configurational centre closer to the carrier. Integration is distributed in a consistent pattern. The core is composed of the carrier space, the space which connects sector 3 to the deepest sector (1 or 2, depending on the experiment), and the space between these two spaces. The latter is the most integrated of all, followed by the 'boundary' space and the carrier space. This pattern is so prevailing that it is only 'corrupted' when the carrier is fully melted to sector 3, pulling the integration core to itself. Nonetheless, the spaces at the boundaries between the sectors follow the carrier in order of integration.

Increasing the connectivity of the carrier is only effective in changing the rank order of integration of the sectors when sector 1 is opened to the carrier. In the remaining situations the original rank order of integration *3<2<1* is kept intact. However, when the most integrated space per sector is observed, a curious pattern emerges. The rank order is modified placing the most integrated space of the sector which has been melted in the lowest position of the rank. This is because integration is balanced in order to compensate the access to the more isolated sector. This phenomenon does not occur when sector 3 is connected to the carrier, because of its central position in the configuration.

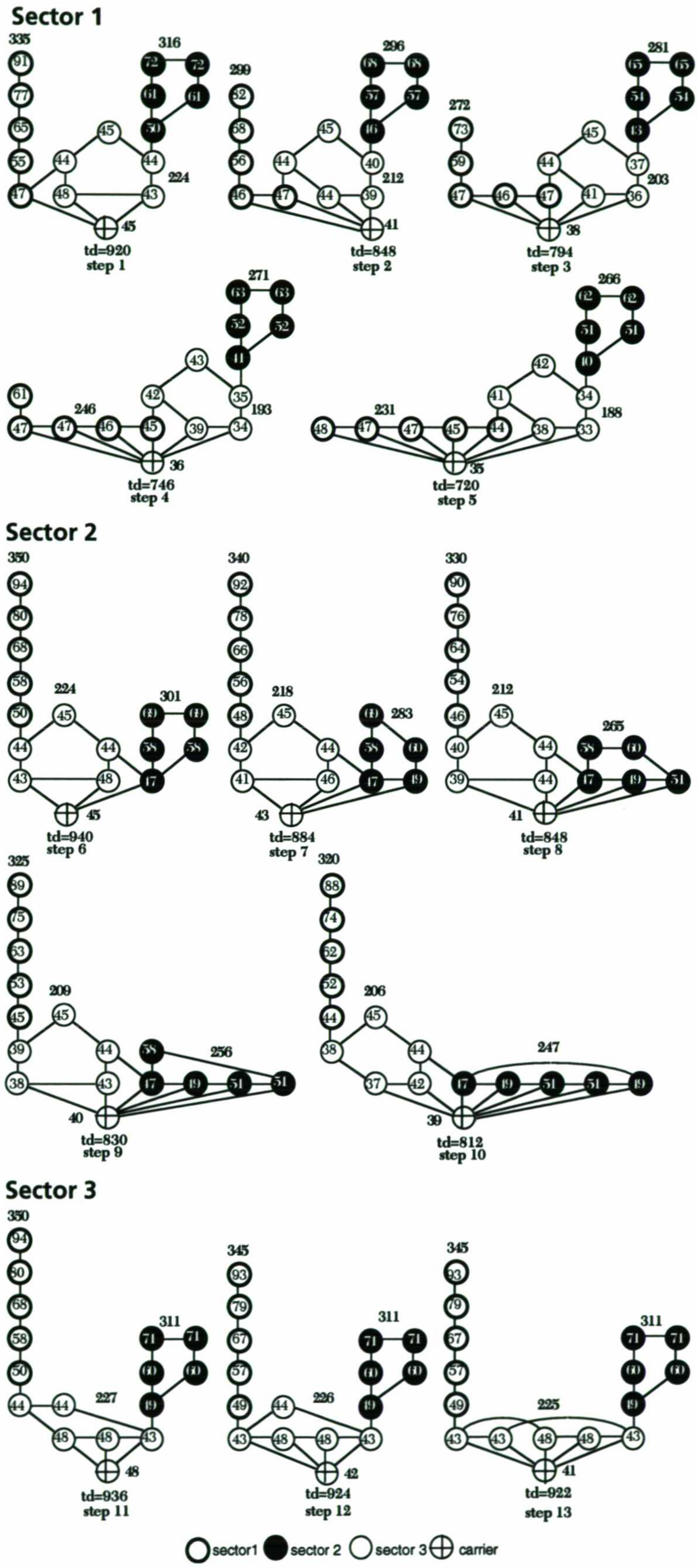


Figure 7.8. Connecting the sectors to the carrier space

Regardless of the shifts in the inequalities amongst the sectors, stability is again present in the graphs. When sector 1 is connected to the carrier space, sector 2 remains stable, with depth values proportionally reduced every time connectivity is increased. The same phenomenon occurs when the boundary of sector 2 to the carrier is melted. In both cases, sector 3 changes in a less predicted way, but always balancing minimal depth towards the unchanged sector. Symmetry and stability is however, clearly seen when the connectivity of sector 3 to the carrier is increased.

7.1.4. The flow of integration through the sectors

Figure 7.9. summarise the results of the experiments by plotting the total depth loss per sector in each operation. Sector 1 is the most affected in every experiment because depth minimising processes are more effective in tree-like systems. Sector 1 is followed by sector 3, unless the sectors are connected to the carrier space, when sector 2 is more affected. This results from the high connectivity between sector 3 and the carrier space.

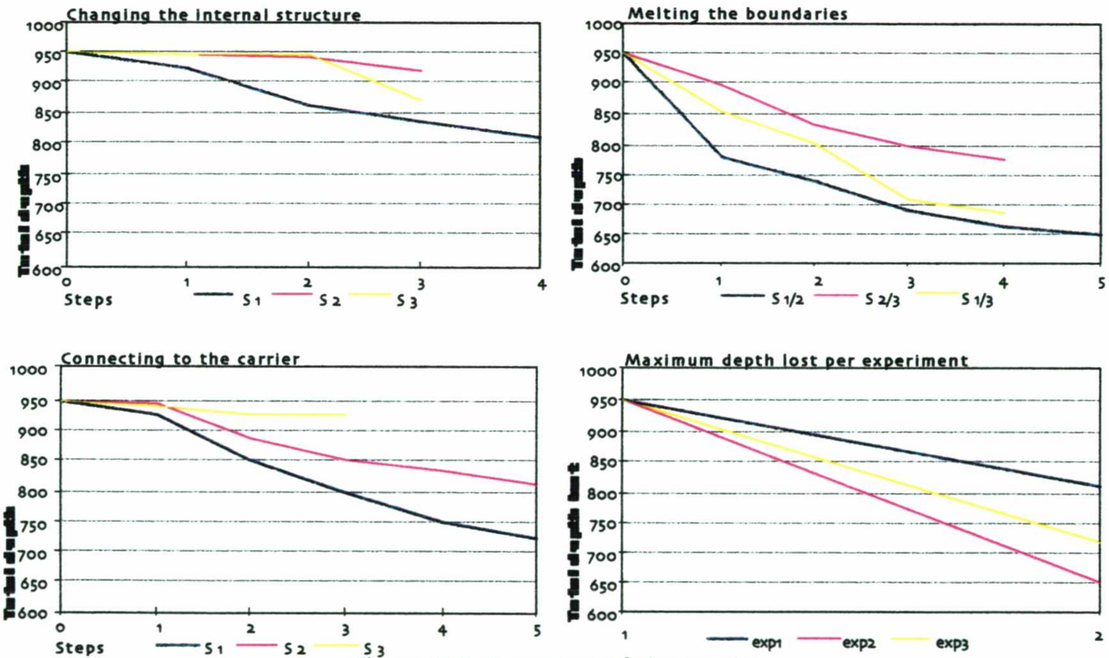


Figure 7.9. Summary of the results

The most important result of the simulations however is that, in this hypothetical building, changes in the boundaries between the sectors are more effective than changes in their internal structures, as well as in their permeability to the carrier space. The maximum depth loss when the boundaries are melted is 300; followed by 230, when the sectors are opened to the carrier space; and by 140, when the internal structure of the sectors are modified. This is because, by 'fuzzying' the boundaries between the sectors, depth is more efficiently reduced than by simple operations in the sectors themselves, as overall distances in the graph can be drastically reduced. In fact, the depth loss generated by melting the boundaries is always higher than any internal changes in the sectors. Only when the deep tree-like sector 1 is connected to the carrier space does it produce higher depth loss than one of the operations in melting the boundaries (sectors 2 and 3). This due to the fact that changes in ringy structures are less effective than in trees, as accessibility is more evenly distributed.

In terms of space integration, the experiments show interesting results, which can be described as follows:

a. Closed bounded sectors symmetrically composed tend to establish the centre of integration in the boundaries between the sectors, regardless of their internal structure. Therefore, the clearer the boundaries of the sectors are, the more the integration core would tend to move towards their boundaries. This shall be called the 'boundary effect'.

b. When the sectors' boundaries are fuzzy and high connectivity is achieved, the centre will tend to move towards an eccentric position, balancing the isolation of one sector with the permeability between the other two. This shall be called the 'isolation effect'.

c. The 'boundary effect' is less effective when a stronger configurational centre is created. In this case, the carrier space drags integration towards itself. Even so, this 'carrier effect' is always balanced by a deeper and isolated sector. The carrier effect can be related to the 'paradox of centrality' as proposed by Hillier when referring to the laws of emergence of settlements (Hillier, 1996: pp 339-341). According to the author, in a circular aggregate integration tends to be concentrated at the centre of the system, weakening towards its edges. However, when the system is considered in relation to its surrounding spaces, integration tends to migrate from its centre to its boundaries. The carrier seems to restructure the integration core of the system in a similar way.

Just as strikingly as the graphs' changing patterns is how some of their properties are kept stable. Stability is manifested in particular ways:

a. When changes are introduced to the internal arrangements of a sector, depth is proportionally distributed amongst the spaces of the remaining ones.

b. Stability is also present in the position of the most integrated space. In general, its position does not change when topological symmetries are maintained. This is the case when the internal structure of the sectors are changed. However, this is not a general rule. When the boundaries between the sectors and between the sectors and the carrier space are changed, the most integrated space tends to shift positions, but as soon as it moves to another space, it tends to be stable, regardless of further changes added to the system. This means that to relocated the centre of integration of a building, it is only necessary to make a strategic move to reformulate its configuration, but after this move, the system keeps its centre stable again. For example, when the boundary between sectors 2 and 3 is melted, the shallower space is isolated in one of the spaces which composes the centre of the original building. Other spaces may assume the same depth value during the 'melting' process, but one space is kept highly integrated in all operations. The only exception to that is when the carrier space drags integration to itself in the last stage of the melting process with sector 3. Nevertheless, the carrier is followed by the space which previously assumed the integration centre of the system.

c. The rank order of integration of the most integrated spaces per sector, *3<2=1*, is kept constant (see table 7.2). Moreover, the most integrated spaces in each sector are exactly the same, apart from the cases referred to, above.

In sum, internal changes in the sectors are more conservative, whereas changes in sectors' boundaries are more effective. One sustains the established order, whereas the other challenges the order to create new forms of spatial configuration.

7.2. Introducing mediation

Figure 7.10. shows a modified version of the hypothetical building with the introduction of a mediator unit separating the sectors. The mediator is positioned as a cut vertex, a position that is likely to pull the configuration towards its boundaries, but it is worth observing how the whole complex behaves with its introduction. The sectors are represented in the justified graph as previously, and the mediator space is highlighted with a shaded pattern.

The simulations with the mediated system follow exactly the same procedures used previously and the results are presented similarly, but an important observation must be made before describing the results of the analysis. The values expressed in depth do not allow a direct comparison between the mediated and non-mediated systems, because they are of different sizes. To compare the numerical results, the depth values should be transformed to RRA, according to the procedures enumerated by Hillier and Hanson (Hillier and Hanson, 1984: pp 109-113).[37] As the interest of the experiment is not a direct comparison between the two systems but the effect of the sectors' organisation in these two types of arrangements, the 'relativisation' of the depth value is not necessary. Furthermore, it is also believed that expressing topological distances in depth values makes the argument clearer for the reader.

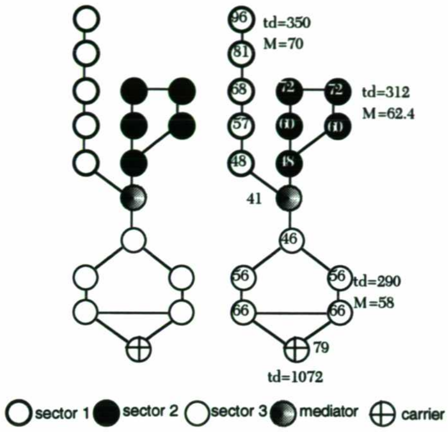


Figure 7.10. Justified graph of a mediated hypothetical building

The mediated hypothetical building presents the following syntactic properties. Sector 1 is the most segregated sector with total depth of 350, followed by sector 2 (312) and sector 3 (290). The mediator is the shallowest space of all with total depth of 41, followed by the spaces immediately connected to it in each sector. The centrality effect is perceived by the drastic increase of depth from the mediator towards the more peripheral spaces. The presence of a single strong integrator stands out as the main differential between the two hypothetical buildings. Another particular property of this symmetrical system is the regular distribution of depth inside the sectors 2 and 3. It is interesting to observe how these patterns are altered when changes are introduced to the system. The summary of the analysis is given in figure 7.11. and tables 7.3 and 7.4.

37 The mathematical procedure is reproduced in Appendix 1.

Table 7.3. Result of the experiment: mediated system

		M	c	Sector 1		Sector2		Sector3	
Experiment 4 Changing the internal structures									
Hypothetical building	sum	td	td	td	m	td	m	td	m
	1072	41	79	350	70.0	312	62.4	290	58.0
Sector1									
Step 1	1044	40	78	334	66.8	307	61.4	285	57.0
Step 2	972	37	75	298	59.6	292	58.4	270	54.0
Step 3	948	36	74	286	57.2	287	57.4	265	53.0
Step 4	920	35	73	270	54.0	282	56.4	260	52.0
depth loss	152	6	6	80	16.0	30	6.0	30	6.0
Sector 2									
Step 5	1070	41	79	350	70.0	310	62.0	290	58.0
Step 6	1068	41	79	350	70.0	308	61.6	290	58.0
Step 7	1042	40	78	345	69.0	294	58.8	285	57.0
depth loss	30	1	1	5	1.0	18	3.6	5	1.0
Sector 3									
Step 8	1024	39	67	340	68.0	302	60.4	276	55.2
Step 9	1000	38	67	335	67.0	297	59.4	263	52.6
Step 10	998	38	67	335	67.0	297	59.4	261	52.2
depth loss	74	3	12	15	3.0	15	3.0	29	5.8
Experiment 5 - Melting the boundaries									
Hypothetical		M	c	Sector 1		Sector2		Sector3	
building	sum	td	td	td	m	td	m	td	m
	1072	41	79	350	70.0	312	62.4	290	58.0
Sector 1/ Sector 2									
Step 1	1022	41	79	325	65.0	287	57.4	290	58.0
Step 2	982	41	79	305	61.0	267	53.4	290	58.0
Step 3	944	41	79	286	57.2	248	49.6	290	58.0
Step 4	922	41	79	275	55.0	237	47.4	290	58.0
Step 5	900	40	78	264	52.8	233	46.6	285	57.0
depth loss	172	1	1	86	17.2	79	15.8	5	1.0
Sector 2 / Sector 3									
Step 6	1012	41	74	350	70.0	282	56.4	265	53.0
Step 7	978	41	69	350	70.0	265	53.0	253	50.6
Step 8	952	41	67	350	70.0	252	50.4	242	48.4
Step 9	926	41	63	350	70.0	239	47.8	233	46.6
Step 10	914	41	61	350	70.0	233	46.6	229	45.8
depth loss	158	0	18	0	0.0	79	15.8	61	12.2
Sector 1/Sector 3									
Step 10	1012	41	74	320	64.0	312	62.4	265	53.0
Step 11	956	41	66	292	58.4	312	62.4	245	49.0
Step 12	912	41	63	270	54.0	312	62.4	226	45.2
Step 13	882	41	59	255	51.0	312	62.4	215	43.0
Step 14	860	40	58	244	48.8	307	61.4	211	42.2
depth loss	212	1	21	106	21.2	5	1.0	79	15.8
Experiment 6 - Connecting to the carrier									
Hypothetical		M	c	Sector 1		Sector2		Sector3	
building	sum	td	td	td	m	td	m	td	m
	1072	41	79	350	70.0	312	62.4	290	58.0
Sector 1									
Step 1	968	39	47	310	62.0	302	60.4	270	54.0
Step 2	928	39	43	290	58.0	302	60.4	254	50.8
Step 3	898	39	40	275	55.0	302	60.4	242	48.4
Step 4	846	37	38	247	49.4	292	58.4	232	46.4
Step 5	818	36	37	231	46.2	287	57.4	227	45.4
depth loss	254	5	42	119	23.8	25	5.0	63	12.6
Sector 2									
Step 6	968	39	47	340	68.0	272	54.4	270	54.0
Step 7	948	39	45	340	68.0	262	52.4	262	52.4
Step 8	927	39	43	340	68.0	251	50.2	254	50.8
Step 9	918	39	42	340	68.0	247	49.4	250	50.0
Step 10	908	39	41	340	68.0	242	48.4	246	49.2
depth loss	164	2	38	10	2.0	70	14.0	44	8.8
Sector 3									
Step 11	1017	40	66	345	69.0	307	61.4	288	57.6
Step 12	1010	40	65	345	69.0	307	61.4	287	57.4
Step 13	1008	39	53	340	68.0	302	60.4	286	57.2
depth loss	64	2	26	10	2.0	10	2.0	4	0.8

c - carrier space; M - Mediator; td - total depth; m - mean value

Table 7.4. Rank order of integration of the sectors: mediated building

Experiment 4			**Experiment 5**			**Experiment 6**		
	Mean depth by sector	Space by sector		Mean depth by sector	Space by sector		Mean depth by sector	Space by sector
System	3<2<1	3<2=1		3<2<1	3<2=1		3<2<1	3<2=1
Sector1			**Sector 1/ Sector 2**			**Sector 1**		
Step 1	3<2<1	3<2=1	Step 1	2<3<1	1=2<3	Step 1	3<2<1	1<2=3
Step 2	3<2<1	3<2=1	Step 2	2<3<1	1=2<3	Step 2	3<1<2	1<2=3
Step 3	3<1<2	3<2=1	Step 3	2<1<3	2<1<3	Step 3	3<1<2	1<2=3
Step 4	3<1<2	3<2=1	Step 4	2<1<3	2<1<3	Step 4	3<1<2	1<2=3
			Step 5	2<1<3	2<1<3	Step 5	3<1<2	1<2=3
Sector 2			**Sector 2 / Sector 3**			**Sector 2**		
Step 5	3<2<1	3<2=1	Step 6	3<2<1	3<2<1	Step 6	3<2<1	2<1=3
Step 6	3<2<1	3<2=1	Step 7	3<2<1	3<2<1	Step 7	3=2<1	2<1=3
Step 7	3<2<1	3<2=1	Step 8	3<2<1	3<2<1	Step 8	2<3<1	2<1=3
			Step 9	3<2<1	3<2<1	Step 9	2<3<1	2<1=3
			Step 10	3<2<1	3=2<1	Step 10	2<3<1	2<1=3
Sector 3			**Sector 1/Sector 3**			**Sector 3**		
Step 8	3<2<1	3<2=1	Step 10	3<2<1	3<1<2	Step 11	3<2<1	3<2=1
Step 9	3<2<1	3<2=1	Step 11	3<1<2	3<1<2	Step 12	3<2<1	3<2=1
Step 10	3<2<1	3<2=1	Step 12	3<1<2	3<1<2	Step 13	3<2<1	3<2=1
			Step 13	3<1<2	3<1<2			
			Step 14	3<1<2	3<1<2			

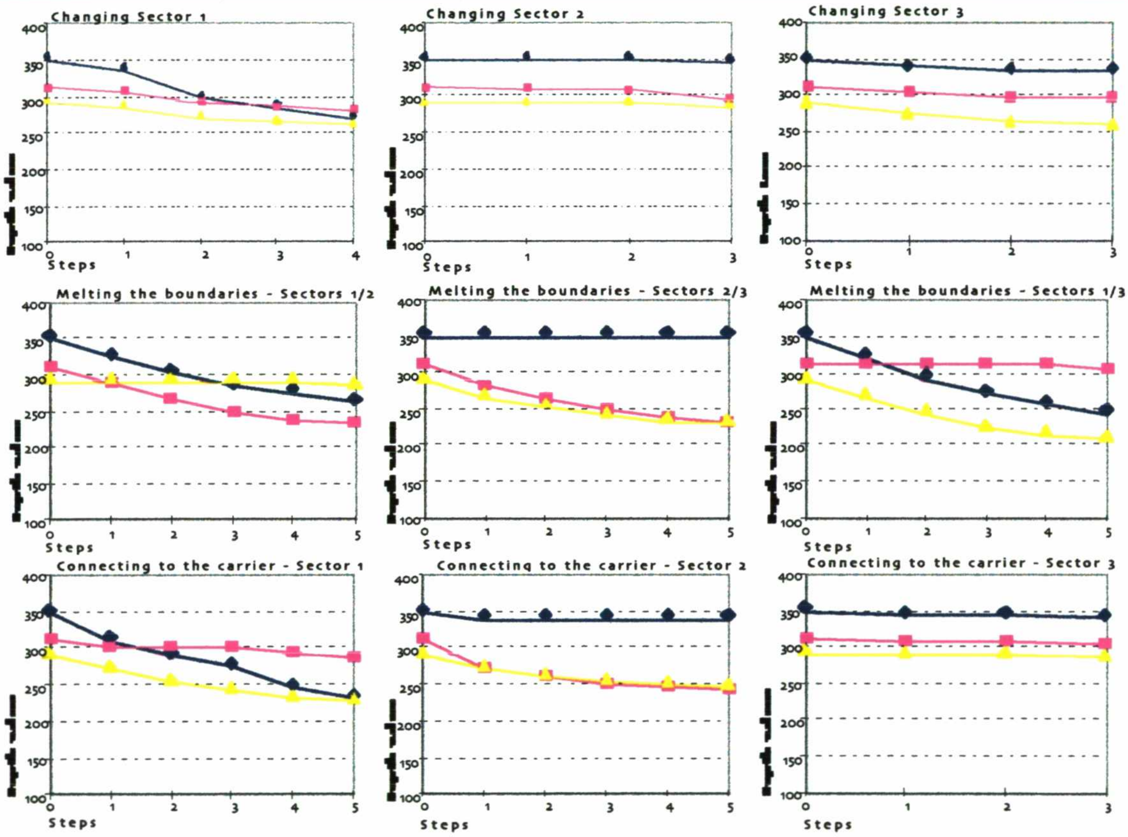


Figure 7.11. Total depth loss per sector in each experiment: mediated building

7.2.1. Experiment 4: changing the internal structure of the sectors

The results are remarkably similar to the previous experiment (figure 7.12). Changes in the tree-like system are again more effective than changes in sectors 2 and 3. The total depth loss generated by reducing depth in sector 1 is 152, against 74 in sector 3, and 30 in sector 2. Depth loss per sector is higher when changes are directly introduced to them, as proved in the previous experiment. The total depth loss by sector 1 is 80, by sector 2 is 18 and by sector 3 is 29.

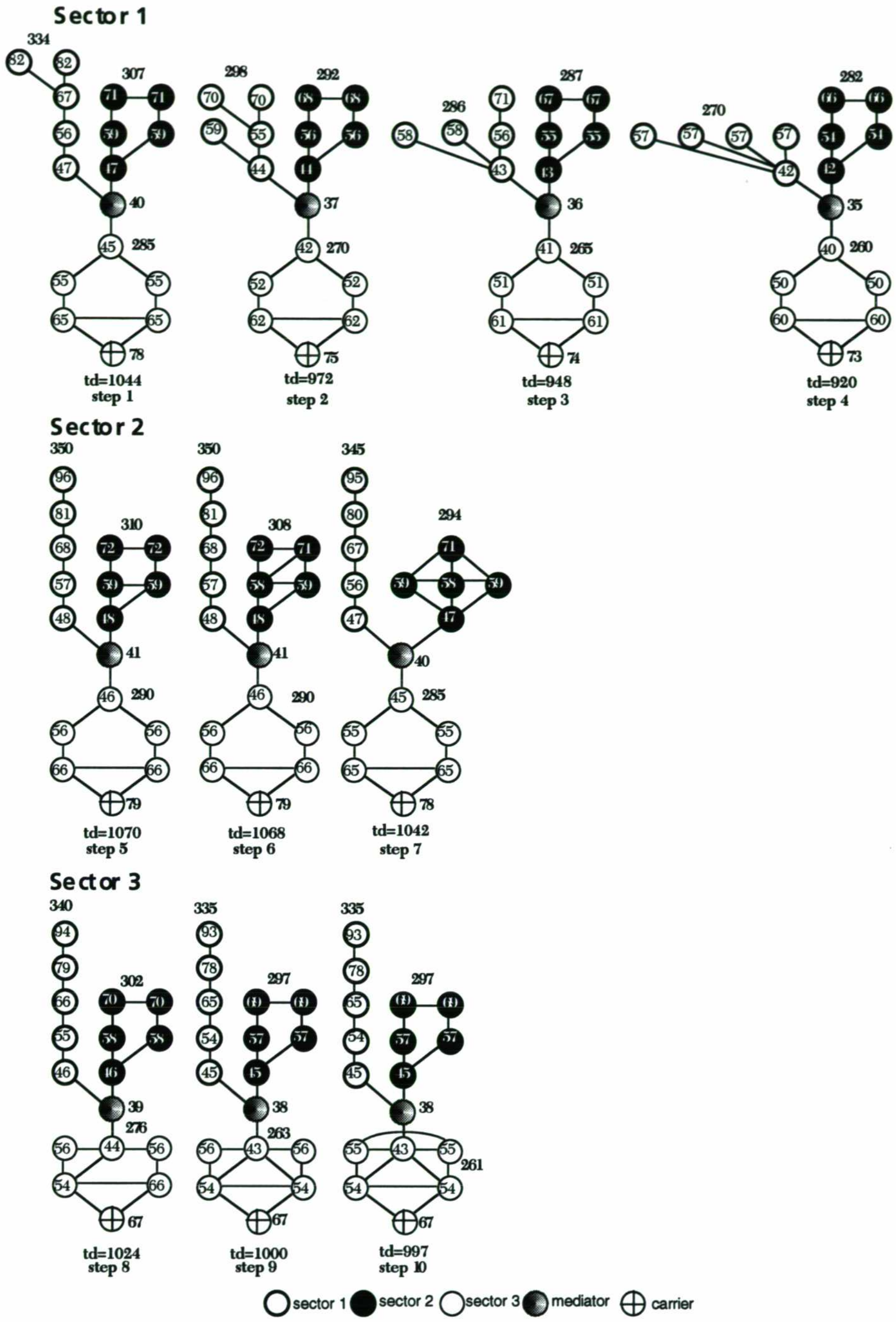


Figure 7.12. Mediated building: changing the internal structure of the sectors

When the depth loss of the carrier and the mediator spaces is compared to the mean depth loss per sector, they are always amongst the least affected. When changes are introduced to sectors 1 and 2, the carrier and the mediator space have the same depth loss (6 and 1, respectively) as the mean value for the remaining sectors. The carrier space loses more depth (12) when changes are introduced to sector 3. This is because the carrier gets closer to the mediator and consequently to the deeper sectors. Notwithstanding this result, the carrier remains quite segregated in relation to the whole system.

The mediator space remains at the shallowest position, always followed by the spaces directly connected to itself, for example, the space which connects the sector 3 to the mediator is the second most integrated node. The maximum depth loss by the mediator space is 6, when maximum depth loss is imposed to sector 1. As in the previous experiment, the stable position of the configurational core is related to the spatial segregation of the sectors, perfectly bounded and isolated from each other by means of the mediator space.

The rank order of integration of the sectors is quite similar to the one seen in the non-mediated system, *3<2<1*. This order is only changed when sector 1 assumes its shallowest position (steps 3 and 4), when it becomes shallower then sector 2. The rank order of the sectors is more stable when observed by the order of their most integrated spaces. In this case, the original order 3<2=1 is not changed in any circumstance.

One interesting property of the mediated graphs is the symmetrical distribution of depth values in the sectors, and the proportional depth reduction every time a change is introduced. The even and proportional distribution of values amongst the spaces is caused by the symmetrical arrangement of the hypothetical building, yet reinforced by the 'mediation effect' which further isolates the effects of these changes. But the most remarkable property of these graphs is the consistency by which depth is distributed within the sectors. When changes are introduced in one sector, the remaining sectors respond to these changes in a very consistent pattern, reducing depth proportionally, therefore keeping the order of integration of the spaces intact. The reason for such behaviour is the introduction of a mediator space, which reduces, or orders, the effect of changes and distributes depth more evenly in the system. This property is extremely important because it is known that it is through the inequalities present in space configuration that society manifests itself by assigning different kinds of functions in particular spaces. In this sense, the experiment shows that mediated symmetrical systems have strong 'inequality genotypes' (Hillier, Hanson et al., 1987), which survive deep changes in their configurations.

7.2.2. Experiment 5: melting the boundaries of the sectors

Melting sectors' boundaries generates more depth loss than when the sectors are internally changed (figure 7.13). The highest depth loss is generated when the boundaries between sectors 1 and 3 are melted (212) followed by the boundary between sectors 1 and 2 (172), and sectors 2 and 3 (154). Sector 1 is again the most affected with a maximum depth loss of 106, followed by the remaining sectors (depth loss of 79).

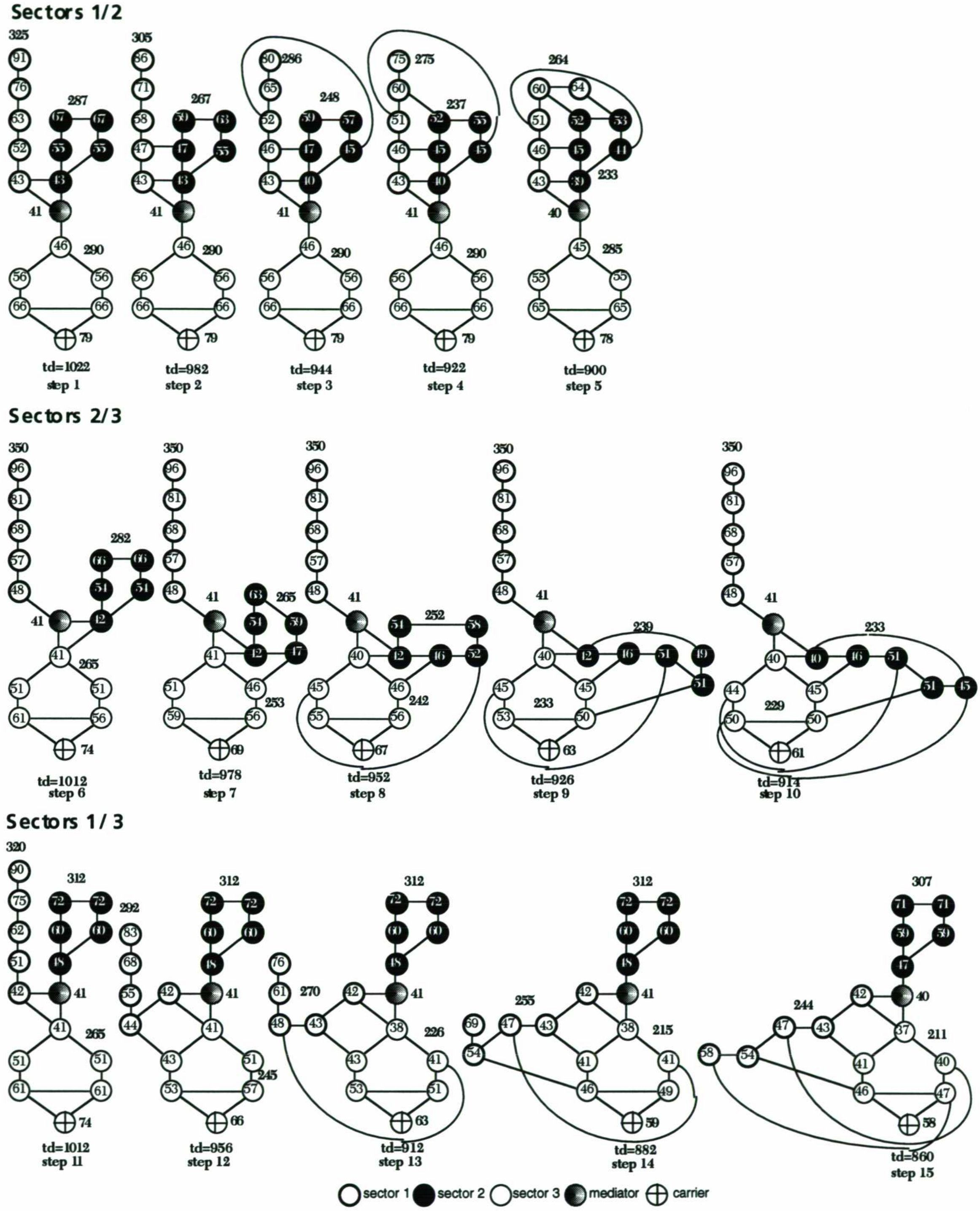


Figure 7.13. Mediated building: melting the boundaries

The maximum depth reduction per sector is reached when direct changes are introduced to sectors' respective boundaries, as seen in the previous non-mediated building. The remaining sector is the least affected with these changes. For example, when the boundary between sectors 1 and 3 is melted, sector 3 is only affected in the last melting stage. The same occurs when sectors 1 and 2 are melted, and particularly when sectors 2 and 3 are melted, generating no depth loss to sector 1. These results reflect a 'configurational inertia' imposed by the mediator sector, as it minimises the effects of configurational changes in the system.

In this experiment, the original rank order of integration of the sectors changes gradually, following an interesting pattern (see table 7.4.). When the boundaries start to be melted, the order changes slowly concentrating integration in the 'ringiest' sector and segregation in the unchanged sector. For example, when sectors 1 and 2 are melted, the most integrated sector becomes sector 2, which is followed by 3, but soon substituted by sector 1. The same happens when sectors 1 and 3 are melted. The original sequence *3<2<1* remains stable when the connectivity between sectors 2 and 3 is increased, for the same reasons.

The location of the most integrated space is also of interest. The mediator space remains at the centre in the initial stages of the melting process, but soon the most integrated space moves to one of its adjacent spaces which belongs to one of the melted sectors, normally the ringy one. The mediator space, however, maintains its central position, being in all cases the second most integrated space. This pattern suggests that when melting sectors' boundaries of highly symmetrical mediated systems, the most integrated spaces would be the spaces of the melted sectors which are connected to the mediator space, and the mediator itself.

7.2.3. Experiment 6: connecting the sectors to the carrier

Connecting the sectors to the carrier produces more depth loss for the sectors 1 (250) and 2 (164), then in the previous operations (figure 7.14). Similar to the non-mediated system, the reduced depth loss by sector 3 is a consequence of its direct connection to the carrier. It is also the reason why it is the only operation in which changes in sector 3 generates more depth loss in the remaining sectors than in sector 3 itself. In fact, increasing carrier's connectivity to the other sectors follows the general rule that predicts that direct changes to the sectors are more efficient than changes in other parts of the system.

However, the strength of the mediator space is still present in this experiment. It remains as the most integrated space in every single stage, being strongly differentiated when the carrier and sector 3 are melted. The space order of integration follows from the mediator towards the carrier space, being their connecting space the second in integration. These spaces are immediately followed by the spaces adjacent to the mediator node.

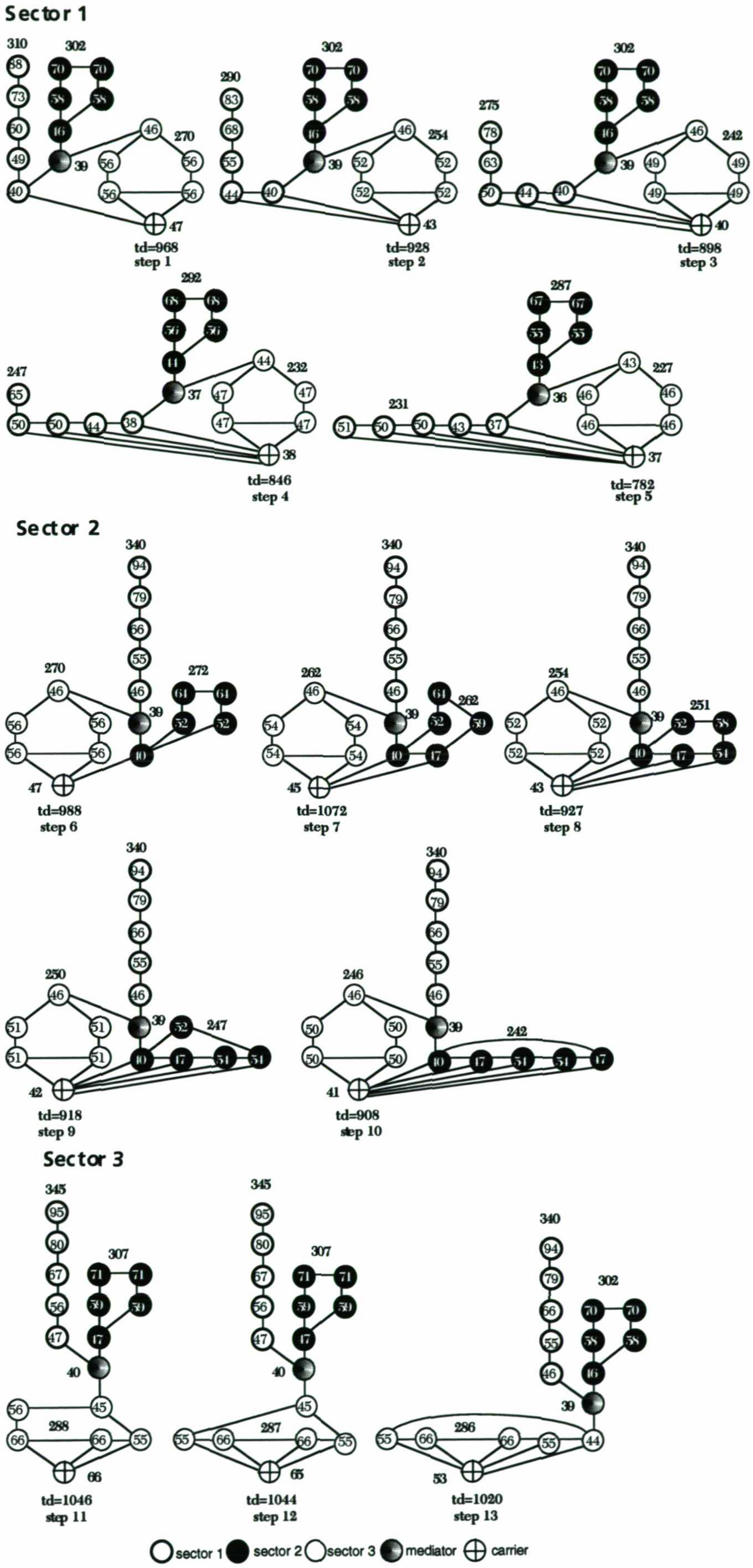


Figure 7.14. Mediated building: connecting to the carrier

As it would be expected, the carrier space is more affected than in any previous operation. It presents a depth loss of 42, when it is connected to sector 1, followed by sectors 2 (38) and 3 (26). Curiously, increasing the connectivity between the carrier space and sector 3 does not bring the integration core to the carrier. On the contrary, it remains deep around the mediator space, responding to the isolation that the mediator imposes to the remaining sectors. However, when the average depth loss per sector is compared to the depth loss by the mediator and carrier spaces, the carrier stands out as the most affected of all. On the other hand, the mediator, albeit being the most integrated space of all, loses less depth in all steps.

The original rank order of integration of the sectors, *3<2<1*, is changed to integrate the sector which is melted with the carrier space. However, when sector 1 is connected to the carrier it becomes more integrated than sector 2, but sector 3 remains the most integrated of all, because reducing depth in sector 1 also affects sector 3 positively. The effect of connecting the sectors to the carrier space is perhaps better evaluated by ranking the order of integration of spaces by sector. The effect of this operation is to adapt the original order *3<2=1* to place the most integrated space in the sector which has been opened up to the carrier.

The most remarkable result of this experiment is the proportional depth re-distribution within the sectors when a connection is added. The system balances distances by keeping the internal distances proportionally stable (the values are evenly reduced), whereas the melted sector drastically reduces its depth values. The only significant change between the original mediated system and the ones generated by this operation is the equal depth value assumed by the shallowest spaces of sector 3, even though it is changed under the general law of proportionality and stability.

7.2.4. The mediated flow of integration

Figure 7.15. summarises the results by plotting the total depth loss of each sector in each step of the experiment. The depth loss pattern is similar to the non-mediated one. Sector 1 is the most affected of all followed by sector 3, when changes to their internal structures are added, and sector 2, when they are connected to the carrier. The fact that sector 1 is the deepest sector of all also determines its high depth loss value when its boundaries are melted. But the most interesting result is the effectiveness of connecting the sectors to the carrier space, which produces the highest depth loss of all operations, exactly when sector 1 is connected to the carrier space (254). This outcome contrasts

with the non-mediated system in which the highest value was obtained when the boundaries between the sectors were melted. This result, however, only confirms the generic rule that opening up the boundaries of the sectors, either to the carrier space or to another sector, is the more efficient way to reduce depth in the system.

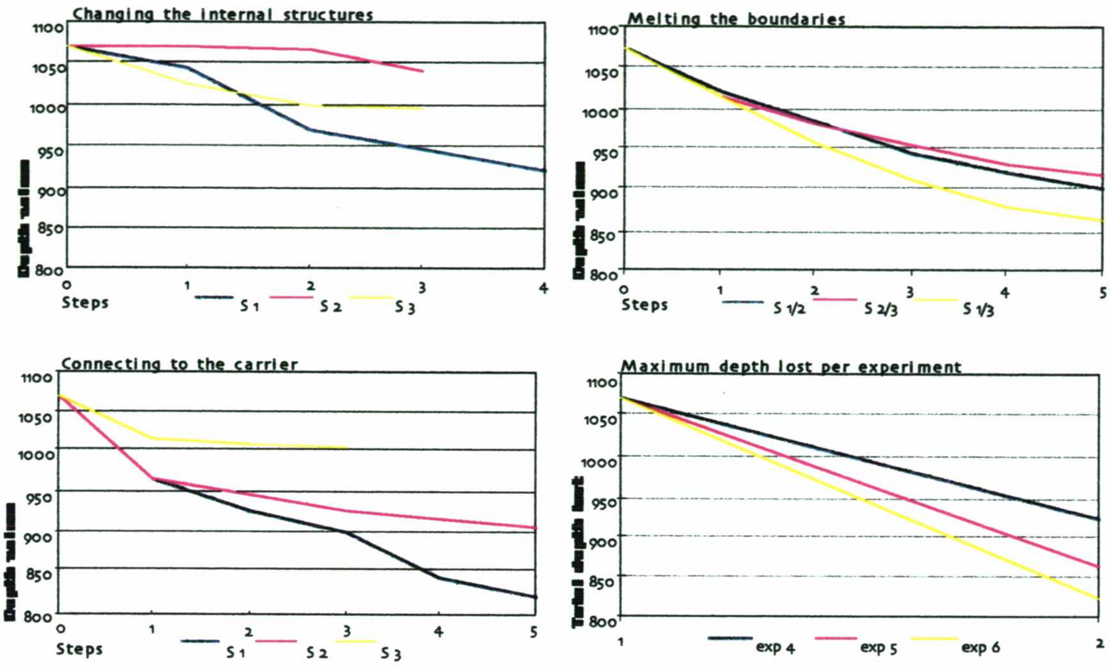


Figure 7.15. - Mediated building: summary of the results

The use of a mediator space induces the following patterns in the distribution of integration:

a. In a mediated system composed of clear bounded sectors, symmetrically positioned from the point of view of the mediator, the most integrated spaces are the mediator itself and its adjacent spaces, regardless of the internal configuration of the sectors.

b. When the boundaries of the sectors are melted, the mediator space remains at the centre of the system until the final stages of the 'melting' process, when the centre of integration moves towards the most permeable sector, one step away from the mediator. This is because mediation, understood as a process of separating different categories of spaces, does not occur any longer, as high permeability between sectors obscures the mediation effect. In this case, the mediator unit assumes a secondary role in the system, albeit remaining central.

c. The mediator space, by isolating the sectors, minimises the effect of changes introduced in one sector to the others. This is seen throughout the experiment, but more clearly when the sectors are connected to the carrier space and when the boundaries between the sectors are melted. In this particular operation the third sector is almost unaffected.

d. The mediator space has a relatively low depth loss, but notwithstanding this fact, it remains at the centre of the system. This suggests that mediated systems tend to maintain stable their configurational core.

The introduction of the mediator space seems to have increased the degree of stability of the system. Stability is present in the location of the most integrated space, the rank order of integration of the sectors and the most integrated space per sector. For example, internal changes in the sectors do not affect their rank order of integration, nor the inequalities amongst the most integrated spaces per sector. On the other hand, when the boundaries are changed, the same unpredictability seen in the non-mediated building is also experienced. The order of integration is slowly altered according to the degree of permeability assumed by the sectors. However, whichever order the spaces may assume, the most integrated spaces by sector remains exactly the same, which are the spaces adjacent to the mediator space. This phenomenon not only confirms the symmetrical and convergent composition of the system, but also expresses the strength of the mediator space even when boundaries are melted and asymmetry takes control of the system. In summary, it seems that mediation is the best source for maintaining a configurational order, even when structural changes are introduced.

7.3. Preliminary conclusions

7.3.1. Comparing the experiments

To understand the effect of sectoring in the pattern of integration of buildings, it is necessary to compare the behaviour of non-mediated and mediated systems. Consistencies may indicate universal properties and inconsistencies may denounce particularities.

There are some interesting differences between the mediated and non-mediated systems. For example, when the boundaries between the sectors of non-mediated building are melted, the most integrated space moves towards the boundary of the isolated sector, whereas in the mediated building, the most integrated space moves towards the opposite direction, closer to the mediator space. This result is significant because shows how the mediator space concentrates integration and sets apart the components of the system.

Another important difference is in the location of the centre of integration of the buildings. Mediation brings more stability and predictability, so much so that it is possible to predict the effect of changes in the configuration of the system. On the other hand, the non-mediated building is less predictable, possibly because changes are more structural. The stability of the mediated system is a consequence of its strong centrality. This is demonstrated by observing the location of its most integrated spaces. They are always connected to each other, forming a hub of integration. This does not always occur in the non-mediated building, where the most integrated spaces are sometimes disconnected from each other. Therefore, the mediated building reinforces centrality, and the non-mediated one distributes it.

Still discussing the configurational centre of the buildings, both experiments introduce some morphological references for the deep-shallow core issue, as proposed by Orhum, Hillier and Hanson's study on vernacular Turkish houses (Orhum, Hillier et al., 1995; Orhum, Hillier et al., 1996). The authors identified two consistent housing types: an introverted type, with a deep integration, situated around the *sofa* - house's principal room; and an extroverted type, with a shallow integration core, situated around the paved yard. These spatial codes, according to the authors, support two different lifestyles: one keeps traditional values, and the other is westernised. The experiments suggest that there may be some spatial consistencies in defining whether the core is situated shallow or deep from a carrier space. The first aspect is the location of a mediator space, as it tends to draw integration towards itself. If it is situated deep in the system, the core will tend to move up, far from the carrier. The second aspect is the connectivity of the carrier itself. The more open to the outside the system is, the more shallow the core would be.

Stability is presented in both buildings, but more evidently in the mediated one. This is because the mediator space isolates the effect of configurational changes and secures its position at the very core of the building. The stability of the system is increased when mediation is combined with clear sectors' boundaries. In this case, the clearer the boundaries are and, therefore, the more isolated the sectors are, the more stable the system will be. Changes are identified in the levels or numeric values of depth loss or gained by space and sector, but not in their inequalities. This 'boundary effect' is as strong in the mediated as it is in the non-mediated system and, therefore, it may be assumed as a general rule in sectored systems. The clear the boundaries are, the more likely to predict the configurational behaviour of the buildings themselves.

The 'carrier effect', on the other hand, seems to be more effective in non-mediated systems. This is because the mediator space inhibits the potential of the carrier in being a strong integrator. The more powerful the mediator space is, the less powerful the carrier will be. Therefore, to enhance outdoor integration, one has to balance mediation and connectivity to the outside spaces. This shall be called 'mediator/carrier paradox'. This paradox is more pronounced in mediated buildings but it may be manifested in non-mediated ones when a deep and isolated sector exists. In these occasions a 'centripetal' force balances the 'centrifugal' carrier effect. This phenomena, as described previously, is called the 'isolation effect'.

It seems that the way depth is distributed in sectoring buildings is a function of some spatial properties. The existence of clear boundaries is essential to maintain the spatial system stable and to establish the role of each sector in the system, if central or peripheral. Mediation enhances isolation and creates a powerful integration core, pulling integration towards itself. On the other hand, fuzzy boundaries open up the field of combinatorial possibilities, as changes in the configuration are less restricted and the effects of these changes are less predictable. Despite the higher degree of unpredictability, some regularities may still be found. For example, an isolated sector counterbalances the openness of the remaining sectors, pulling integration towards itself. This level of unpredictability is more evident in a non-mediated system, as the openness of the boundaries generates an open spatial field, freed from a central integrator. Therefore, the more asymmetrical the system is, the less predictable it would be. This is why non-mediated buildings are less predictable. In conclusion, the main difference between the two system is that mediated systems are more stable and ordered, topologically speaking; whereas non-mediated systems are less stable and more structured, in a sense that configuration is more susceptible to changes.

7.3.2. The guiding role of the sectors

So, what conclusions can be withdrawn from these experiments? How does it clarify the role of the sectors' organisation in defining the integration pattern of buildings? These question may be addressed by observing that the condition of the experiments does not allow for a generalisation of their results, but it does indicate how sectors' organisation can affect the configuration of buildings. It is true that variables like size and configuration of the sectors act, in order to generate more integration or less integration. In fact, the configuration of the hypothetical building itself has an effective interference in the results of the experiment. However, this interference may be more of degree than of substance, i.e., it may have increased one or another effect, but did not generate them.

One way to understand the way the sectors' organisation may work, is by observing the experiment in a reversed sequence, in other words, as a result of a process of design decision. Starting from scratch, fifteen spatial units (or sixteen if a mediator unit is required) are to be composed according to a brief, to social and cultural habits and to designer's idiosyncrasies. From the various spatial arrangements that were seen,[38] one of those would likely to be used, if the paradigmatic sectoring laws were to be applied. Restrictions in constituting sector 1 as deep and enclosed, for example, would dictate if the integration core would be pushed towards its boundary or not. The need to open up the system to a carrier space, a garden in a domestic unit, would make it more central, regardless of the internal configuration of each sector. Increasing the potential co-presence of users by restraining any barriers between sectors would tend to distribute integration evenly amongst the interconnected sub-systems.

However, this does not predict the integration values with exactitude, but it does indicate the way sectors operate configurationally. It seems that the sectors' paradigm, by defining meso-structures or sub-systems in the overall spatial structure, eliminates spatial inconsistencies (conflicts of activities and undesirable co-presence) and reinforces likeliness. And it is the way these inconsistencies are spatially managed that gives to the system the necessary foundation to 'guide' the constitution of its overall configuration. It is this 'guiding' nature of the sectors that makes the paradigm so pervasive and efficient.

The experiments suggests the existence of two main families of 'genes': those which guarantee more stability to the system and those which are less stable. The first defines isolated and symmetrical sectors, whereas the second introduces asymmetry and blurs the boundaries of the sectors. But regardless of the differences between these two families, the topological genes introduce a certain degree of predictability, stronger in the first family, to the unpredictable configurational world of graphs. They do so by constructing a sort of regularity in the form the systems are composed.

It seems that the effect of the sectors' organisation in the whole configuration of the buildings follows similar principles enumerated by the theory of partitioning (Hillier, 1996: pp 275-334). The theory of partitioning emerged from a theoretical experiment aimed to describe regular shapes syntactically, by representing them as a metric tessellation and analysing the complex of

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[38] Even though the arrangements used in the experiments do not represent all the possible combinations of the fifteen units and the carrier space.

cells as a configuration. The theoretical experiment was developed by closing and opening partitions between the cells, and blocking or opening sets of cells, and calculating the effect of these changes in the overall pattern of integration of the regular shape.

The experiments proved that some of the effects of these changes could be foreseen by the knowledge of some principles. Take the square in figure 7.16., for example. Blocking the connections between the cells in the centre of the shape creates more segregation than if it were placed in its periphery, and if the block is rectangular its effect is even greater. If instead of blocking, voids are generated allowing for a high degree of connectivity of certain units, the effect would be the contrary: 'centrality and linearity will integrate more, squareness and perepherality less' (Hillier, 1999: pp 35.14). The predictability of these effects on the tessellation, and therefore of the graphs, is generated because a sort of geometry was imposed to the system. This geometrisation of the graphs impose some restrictions to the depth distributing process, allowing the prediction of changes in the configuration. This phenomenon is known as the 'law of sufficient geometry' (Hillier, 1999: pp 35.14-35.16).

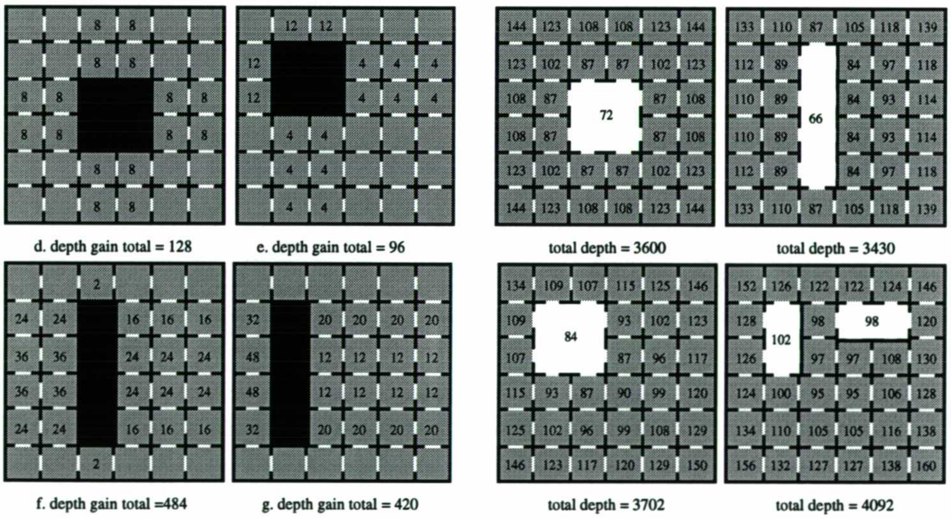

Figure 7.16. Layered tessellation, after Hillier, 1996

It is argued that, similar to the geometrisation of graphs, sectoring generates a significant kind of restrictiveness to the configuration of graphs which is suffice to install some predictable principles. These principles, which have been described above, are not of geometrical nature, but of topological one. Could these preliminary conclusions be taken as general properties of graphs if they were drawn from very specific configurations? Would the mediator effect be as strong as it appears to be in real buildings as it is in the hypothetical building? Would the size of the sectors be an important variable in defining how integration is distributed in the system? Would the carrier space perform differently when sectors of different sizes are connected to it?

The final section of this chapter looks at a sub-set of modern houses, aiming at answering these questions. It repeats the procedures used in the previous experiments, counting universal distances in the houses and expressing the figures in total depth values by space and sectors.

7.4. Back to the modern houses

To proceed the evaluation of how sectoring may guide the configuration of spatial systems, the sub-sample of 20 modern dwellings analysed in the chapter 6 is reviewed on the grounds offered by the morphological experiments described above.[39] The sample is investigated in sets of non-mediated and mediated houses. The comparative analysis observes their depth pattern, but particularly identifies their most integrated space and integration core. The depth pattern of the houses is shown in figures 7.17. and 7.18. The social sector is represented by thin circles, the private by thick circles and the service by black dots. The integration core of the houses, calculated by isolating the 25% most integrated spaces of the dwellings, is highlighted in red. The results of the analysis are summarised in table 7.5, but for the relative connectivity and degree of permeability values discussed in the following sections, see table 6.7.

Table 7.5. Modern houses: general data

Houses	Type	Convex spaces									Integration (RRA)			
		t *	s	s1	se	se1	p	p1	m	m1	Core	%	Rank order	
Non-mediated													all	function
Alcoforado	med	14	4		3		6				4	0.29	s<p<se	s<se<p
Pereira	med	10	2		1		6				6	0.60	p<s<se	s=p<se
Meirelles	med	29	11		2		15				9	0.31	s<p<se	s<p<se
Marinho	med	30	7		9		13				9	0.30	p<se<s	p<s<se
Guerra	med	31	13		7		10				9	0.29	se<p<s	se<s<p
Pontual	med	24	8		5		10				8	0.33	s<p<se	s<se<p
Medeiros	n-med	30	13		1		14		1		10	0.33	s<p<se	s<p<se
Reynaldo	n-med	21	8		4	2	6		2		6	0.29	s<se<p	s<se<p
Chamixaes	n-med	17	3	3	1		6		3		6	0.35	p<s<se	s<se<p
Melo	n-med	9	1		1		5		1		2	0.22	p<s=se	s=se=p
Esteves	n-med	17	2	1	1		10		2		8	0.47	p<s<se	p<s<se
Domingues	n-med	21	4		3	1	9		3		7	0.33	se<s<p	s<p<se
Berinson	n-med	25	9		3		11		1		7	0.28	p<s<se	s<se<p
Masur	n-med	20	4		2		12		1		11	0.55	p<se<s	se<s<p
Campello	n-med	16	4		1		6		2		5	0.31	s=p<se	s<se<p
Castro	n-med	26	6	1	7		6		4		8	0.31	s<se<p	s<se<p
Svenson	n-med	13	2	1	3		5	2	1		4	0.31	s<p<se	s<p<se
Lages	n-med	34	8		11	1	12		1	1	11	0.32	s=se<p	se<s<p
Borsoi	n-med	23	6	1	3		10		1	1	7	0.30	s<p<se	s<se<p
Claudio	n-med	27	8	3	3		9		2	1	9	0.33	p<s<se	s<p<se
Mean mediated		23.00	7.50		4.50		10				7.50	0.35		
Mean non-		21.36	5.57	1.67	3.14	1.33	8.64	2.00	1.79	1.00	7.21	0.34		
Mean all		21.85	6.15	1.67	3.55	1.33	9.05	2.00	1.79	1.00	7.30	0.34		

t=total, s=social, se=service, p=private, m=mediator, m1=mediator1
* The total number of convex spaces includes the carrier space (s)

39 The plans and justified graphs of the houses are presented in figure 6.9.

7.4.1. Non-mediated houses

7.4.1.1. Topological size

The topological size of the non-mediated houses ranges from 10 to 31, with an average of 23 convex spaces. The private sector has, on average, the highest number of convex spaces, 10, against 7.5 for the social, and 4.5, for the service sector. The service sector is the only sector to be composed of a single node (Alcoforado House).

7.4.1.2. The integrator space

The position of the most integrated space follows some of the trends found in the topological experiments. It is either located in the space which links the clearly bounded private sector to the rest of the house, or in the carrier space or its adjacent spaces (figure 7.17). The first case responds to the 'isolation effect' of the private sector and it is seen in Alcoforado, Guerra and Pontual houses. The second case responds to the 'carrier effect' and it is present in Meirelles and Marinho houses. Pereira house is an interesting case, because the combination of two strong poles, the corridor and the carrier, balances the integration between the two.

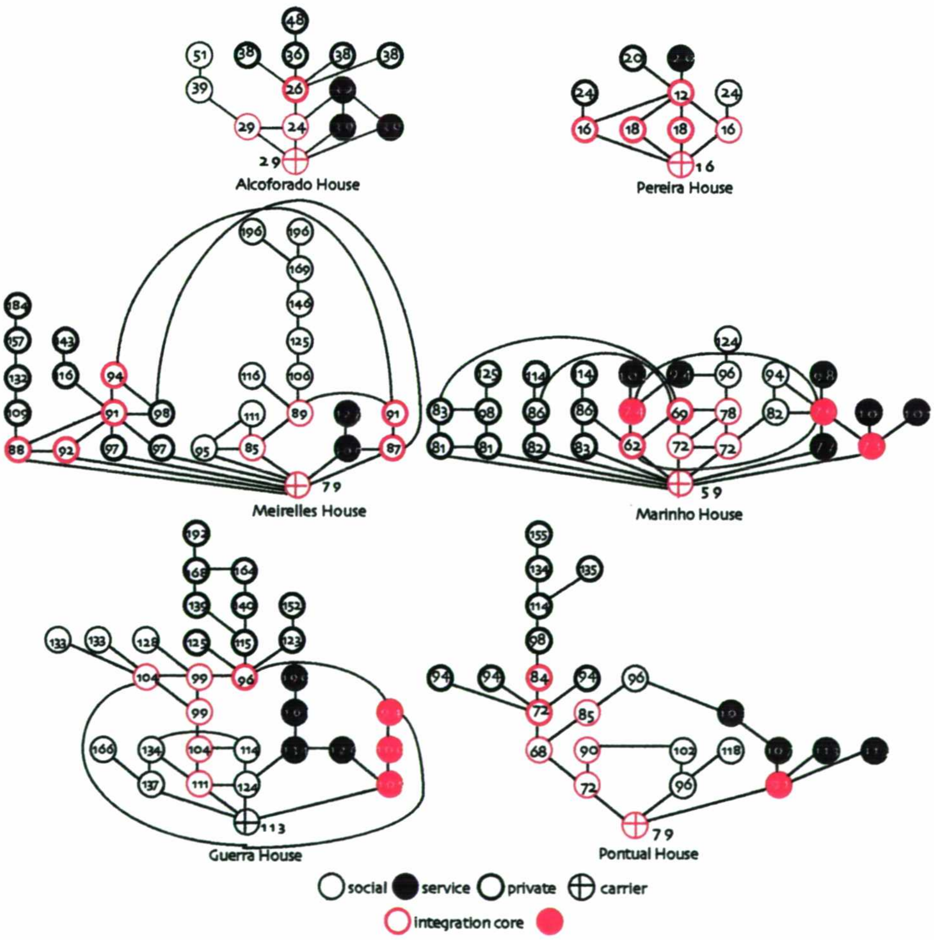

Figure 7.17. Non-mediated modern houses: justified graphs

7.4.1.3. The integration core

If the most integrated space identifies the *locus* of centrality of the houses, the integration core pictures how integration is spread out amongst dwellings' spaces. It shows weather integration is concentrated in a single or many sectors; if its is deep or shallow from the carrier; or if it is ringy or tree-like.

The size of the core ranges from 4 to 9 spaces, but on average it is composed of 7.50 units, corresponding to 35.00% of the spaces. The smallest core is found In Alcoforado House, corresponding to 29.00% of its convex spaces and the largest is found in Pereira house (60%).

The non-mediated houses present shallow cores rooted by the carrier space. Guerra House is the only exemplar which does not include the carrier in its 25% of integration, but it is included in its 30% of integration. Ground-floor houses spread the core around the carrier, whereas first-floor houses pull the integration core to the first floor to include the main functional spaces (living/dining and kitchen in Guerra House and living in Pontual House).

The integration cores of the ground-floor houses are formed by rings, whereas first-floor houses have tree-like cores. The ringy cores are found in the ground floor houses which are more opened to the carrier space and their sectors are less bounded, as their mean degree of permeability of 0.48 attests. On the other hand, three-like cores are found in first floor dwellings which have sectors with clearer boundaries (MDP=0.23). Social and service sectors are in both cases partly opened, but the private sector in ground-floor houses are substantially opened (MDP=0.45), whereas in first-floor houses they are clearly bounded (MDP=0.15).

The integration cores always include social spaces, as all sectors are accessible through them. Private spaces are also present in the integration core of all dwellings. They are present in two circumstances. Firstly, when it is opened to the outdoor spaces, forming continuous rings with the internal corridor (Pereira, Meirelles and Marinho houses), and secondly, when the network of transitional spaces pulls integration closer to the bedrooms (Guerra and Pontual houses). The service sector is commonly secluded, but included in the cores of Guerra, Marinho and Pontual houses.

7.4.1.4. The rank order of integration

The rank order of integration of the sectors shed light upon the effects of sectors' configuration in the overall integration pattern of the hypothetical buildings. However, differences in houses' sectors' size may compromise a comparative analysis. Therefore, the inequalities between the sectors are only evaluated by ordering the most integrated spaces of each sector. The order is expressed in two ways, one by ranking the most integrated spaces regardless of their use as a transitional or a functional space, and the other, by isolating the functional spaces (table 7.5).

Private spaces are relatively well integrated, being the most integrated space in both ranks (all spaces and functional spaces only) in Marinho and Pereira houses. The private living room is Marinho's main integrator, whereas the bedrooms' corridor and the bedrooms are Pereira's most integrated spaces in each rank. Social spaces are more integrated, being the most integrated ones in three houses, but in four houses when the functional spaces are isolated. The relative segregation of the service spaces is due to the isolation of the outbuildings from the analysis, therefore reducing the strategic position of the kitchen in connecting the minimal living complex to the service extensions. This is the case of Alcoforado, Pereira and Meirelles houses. However, the incorporation of the service complex to the minimal living complex does not necessarily enhance their position in the rank order of integration. It does so in Guerra House, because the kitchen links private and social sectors.

The order of integration can be summarised as follows. A social space is the most integrated space when the private sector is attached to the social sector, as in Pontual and Alcoforado houses; a private space is more integrated when the private sector is opened to the carrier (Pereira and Marinho houses), whereas a service space is more integrated when it links the remaining sectors (Guerra House).

7.4.1.5. Concluding remarks

In conclusion, it seems that the integration pattern of the non-mediated houses reproduce to a certain extent the patterns found in the non-mediated hypothetical building. This is quite remarkable, considering that these 'real cases' are asymmetrically composed, their sectors have different sizes and the connectivity between them are randomly displaced. It seems that the level of asymmetry of the houses is always balanced by the 'ordered' aggregation of the sectors. In this sense, the articulation of the sectors tend to prevail over the composition of the sectors themselves.

7.4.2. Mediated houses

7.4.2.1. Topological size

The size of the mediated houses ranges from 9 to 34 convex spaces, with an average of 21.36, which is slightly smaller than the non-mediated houses. The private sector is also the largest sector, with an average of 8.64 convex spaces per house, ranging from 5 (Svenson House) to 14 (Medeiros House). The social sector has an average of 5.57 convex spaces, ranging from the single dining/living room of Melo House to 13 convex partitions in Medeiros house. The service sector is mostly composed of 1 to 3 convex spaces, but Castro and Lages houses have a more complex service sector with 7 and 11 convex partitions respectively, because all the service rooms are included in their minimal living complexes. The average size of the service sector is 3.14 convex units. Mediation tends to be managed by few spaces, 1.79 on average, but Domingues, Chamixaes and Castro houses are more complex, with 3 and 5 mediator spaces.

7.4.2.2. The integrator space

As in the hypothetical buildings, the mediator spaces assume a central position in the overall configuration of the dwellings (figure 7.18). The results reproduce the general tendency to concentrate integration in the mediator spaces or in their adjacent spaces. A mediator space is the most integrated space in seven of the eleven single mediated houses, and the remaining houses (Melo, Esteves, Domingues and Masur) have their integration centre at an adjacent space to a mediator unit.

Double-mediation seems to reduce the strength of mediation, as Lages, Borsoi and Claudio houses confirm. Nevertheless, the most integrated space is always situated at an adjacent position to one of the mediator spaces, and in Lages house, the most integrated spaces, the kitchen and the entrance hall, are adjacent to both mediator spaces. The importance of mediation in the configurational complexes is expressed by its presence in the integration core of every mediated house.

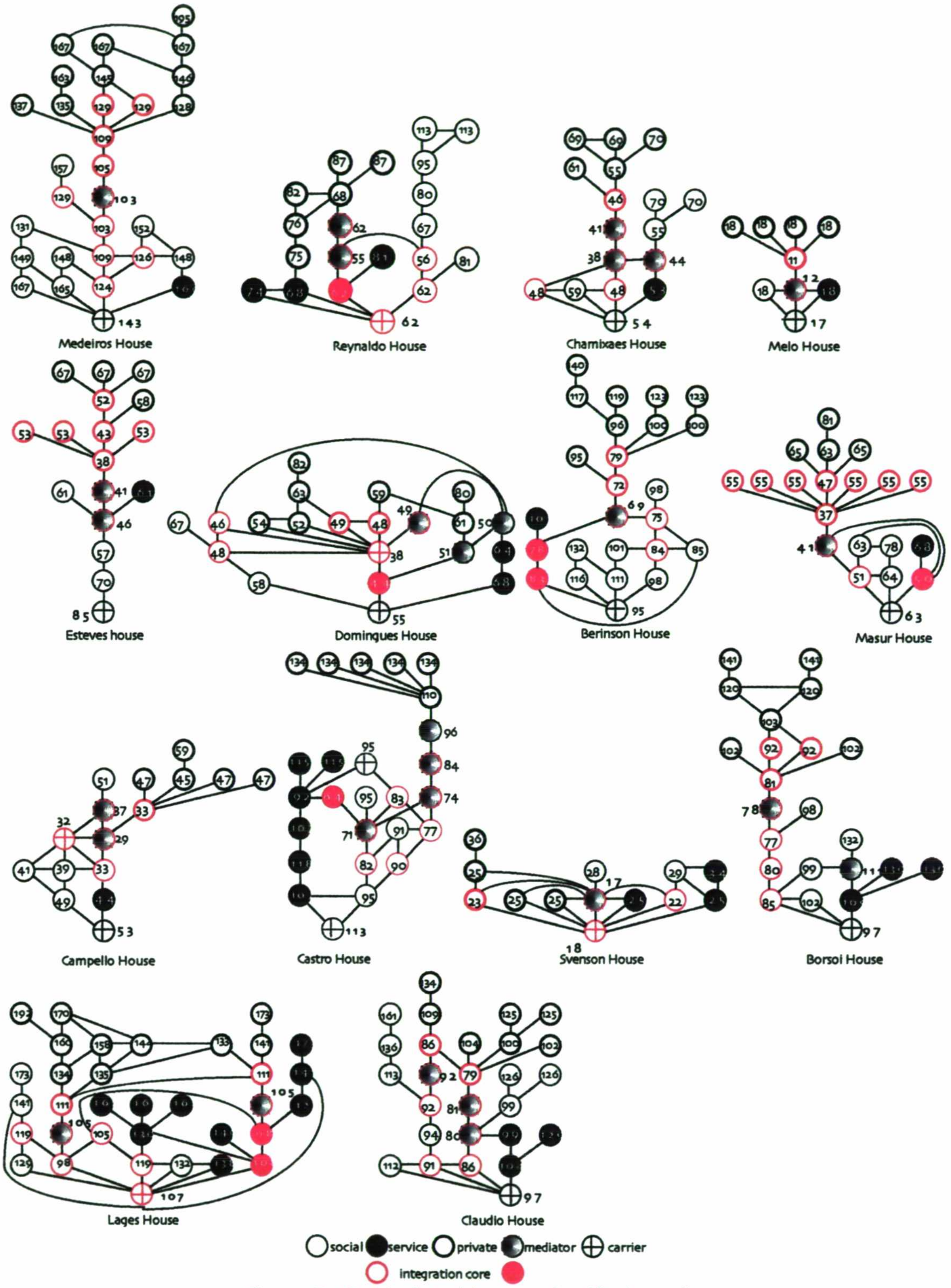

Figure 7.18. Mediated houses: justified graphs

7.4.2.3. The integration core

The average size of the integration core is slightly smaller than of the non-mediated houses, 7.21, corresponding to 34.00% of the average number of convex spaces. The smallest core (Melo House) is composed of two convex spaces (22.20%) whereas the largest comprises 55.00% of Masur House, summing a total of eleven convex spaces.

If the integration core of the mediated houses has, on average, a similar size of the non-mediated houses, its relative position is different. The core tends to be located deeply inside the houses, without including the carrier space. In fact, the carrier is only included in the integration core of Reynaldo, Svenson and Lages houses. In the remaining houses the integration core is usually situated one step away from the carrier, but in Campello and Castro, it is two steps deeper. The deepest core is found in Esteves House, three steps away from the carrier.

As important as the location of the core is the form they assume. Three main configurations are found. Firstly, tree-like cores are found in Chamixaes, Melo, Esteves, Berinson, Masur, Castro, Borsoi and Claudio houses. Secondly, tree-like cores with local rings are seen in Medeiros and Domingues houses. Thirdly, ringy cores, composed of either a single or a sequence of interconnected rings, as seen in Reynaldo, Campello, Svenson and Lages houses. The three-like cores are found in dwellings which have complex, tree-like and isolated private sectors. They seem to be formed by a combination of the mediation and isolation effect, reinforced by the topological weight of the private sector. The only exception is Claudio house (private sector with RC of 0.00 and DP of 0.11), whose core includes well connected social, service and private spaces. In fact, if Claudio's core were calculated by its 30% of integration, it would form a deep ring.

The cores formed at least by one ring are found in dwellings which are more opened to the carrier space and in which boundaries between the sectors are relatively fuzzy. The houses present a MRC of 0.05 and a MDP of 0.91, which is higher than the average values for the three-like-core houses (MRC=0.02, MDP=0.73). These values are more expressive if the ringy-core-houses are isolated (Domingues, Campello, Svenson and Lages), which have a MRC of 0.04 and a MDP of 1.11.

The integration core can also be analysed in terms of its composition. The houses always include mediator spaces in their cores, as well as social spaces, with the exception of Melo House, whose core is formed by two transitional spaces, and Esteves House, whose core is moved upwards to the private sector. In fact, the private sector is present in the integration core of twelve of the fourteen houses. This seems to be an effect of its size and configuration which draws integration to itself. On the other hand, the service sector tends, as in the non-mediated house, to be secluded from the integration core. They are included in the core of five residences, amongst them Lages, Berinson, Masur and Castro houses, which have highly integrated kitchens.

7.4.2.4. *The rank order of integration of the sectors*

The order of integration of the sectors, ranked by their most integrated spaces, shows that the social sector tend to be the centre of the houses. When all the spaces are taken into account, a social space is more integrated in seven houses, whereas when only functional spaces are counted this number is increased to eleven. A service space is found as the most integrated space in Domingues and Lages houses, but when the functional spaces are isolated, only Lages, Melo and Masur houses have a service space as the main integrator of the houses. Private transitional space is the most integrated space of all in Chamixaes, Melo, Esteves, Masur, Campello and Claudio houses, but only Esteves and Melo houses keep a functional private space as the most integrated of all. When functional and transitional spaces are considered, the inequalities $p<s<se$ and $s<p<se$ are the most popular in the sample, present in three and four houses, respectively. When the functional spaces are isolated and ordered, the inequality $s<se<p$ becomes more popular, with six citations, followed by the sequence $s<p<se$, with four citations.

There are some reasons for the prevalence of social spaces in the rank order of integration. The social sector has the highest DP and RC values amongst the functional sectors, therefore being more accessible than the other sectors. These properties of openness and ringiness are reinforced by the relative position of the social sector, shallow from the carrier space, and invariably connected to the service and the mediator sectors. The occasions in which the social sector is reduced to a secondary position are the ones in which the size and configuration of the private sector reinforces the role of the private transitional spaces in accessing a considerable number of convex units. In these houses, both social and service spaces are pushed to the periphery of the system. The extreme case is seen in Esteves House, whose configuration of the private sector is so strong that dominates the rank order or integration of functional spaces as well.

7.4.2.5. *Concluding remarks*

The behaviour of the mediated houses confirms the conclusive results of the experiments. The use of mediator spaces and the definition of clear boundaries establishes a consistent distribution of integration. This consistency allows for predicting, within a certain margin of error, the location of the integration core, as well as the position of the most peripheral spaces. The carrier effect is also present, but always counterbalanced by the strong presence of a mediator space. Despite the similarities between the mediated hypothetical buildings and mediated modern houses, the effect of sectors' size is shown to be quite significant in delineating the pattern of integration of the houses. The size effect predicts that larger sectors would tend to pull integration towards their spaces and boundaries, counterbalancing the strength of spaces which may bind the sectors together

7.5. How the sectors' paradigm seems to work

After observing the depth pattern of modern houses, it is possible to answer the questions formulated in the beginning of this chapter, which were whether the sectors' structure affects the configuration of buildings, and if yes, how this takes place. The experiments with hypothetical spatial systems draw preliminary hypotheses in how sectors may affect the overall configurational pattern of buildings. The evidences suggest that the sectors' boundaries are important in defining an integration pattern, so that the more enclosed the sectors are, the more likely to find the integration core around the spaces responsible for binding the whole system together. This 'joining' process is either done by directly connecting the sectors to each other or through mediator sector(s). When mediation is included, it becomes, almost invariably, the centre of the system, and when it is not, the spaces responsible for rejoining the system become its topological centre.

These preliminary experiments indicate that clear mediated sectors are more predictable than non-mediated sectors and their configuration are more likely to behave under familiar patterns. This predictability, however, is expressed only in how depth is distributed, but not in the actual depth values, as these must be calculated thoroughly. On the other hand, fuzzy bounded and non-mediated systems are less predictable and less conservative. High permeability and the absence of strong connectors, as a mediator space, leaves integration more free to be distributed amongst the spaces. Hence, the joining process does not follow specific conditions but 'circumstantial' procedures. In such complexes, space configuration is less ordered or programmed.

In general terms, the experiments have shown that the clearer the sectors are and the more restricted the mediation process is, the more predictable and conservative they would be. On the other hand, the more open and less mediated the system is, the more challenging and less predictable it would be.

The modern houses of Recife have confirmed most of the hypotheses formulated on the basis of the morphological experiments. Despite the differences in size, the complexity of arrangements, the existence of double mediation and the need to introduce a 'secondary carrier space', in order to represent the existing enclosed patios (Campello, Castro and Domingues houses), the effects of sectors' boundaries, the carrier and the mediator, correspond to those previously described. Non-mediated houses behave in a similar way to the non-mediated hypothetical buildings. The most integrated spaces were found in the same conditions predicted by the experiments. In mediated houses, the predictions were even more accurate. For example, the centrality of the mediator is an indisputable rule. Even in double mediated houses, the strength of the mediators drag integration towards its boundaries.

The sectors' structure of the modern houses also induces the form of the integration core of the houses. Parting from the mediator space, the core tends to be either shallow or deep, according to the relative position of the mediator itself and the degree of openness of the carrier space. The core was shallow and ringy if mediator and carrier were closely related, or deep and tree-like if the mediator was deep, an isolated sector was present and the carrier was poorly connected to the house. In non-mediated houses, the carrier space became, in the absence of a mediator unit, a powerful instrument in reinventing the configuration of the houses. The carrier was present in the integration core of all non-mediated houses. This is because the carrier space was used to create alternative choices of movement about the dwelling.

However conclusive the results of the experiments may be, however supportive the behaviour of the modern dwellings may be, and however logical the proposed theory on the influence of sectoring in the integration pattern of spatial systems may sound, one may argue that, over and beyond the boundaries of sectors, the laws of spatial configuration rule. Indeed, one may argue that the boundaries defined by the sectors are artificially created by a classificatory or labelling procedure which might well be restated by a simple change in space use. Moreover, one may argue that spatial systems, regardless of the functions attached to them, will always perform according to the configurational rules and, therefore, the existence of cut vertices and central spaces will always determine the pattern of integration.

This is absolutely true. The spatial properties captured by series of experiments described in the beginning of this chapter are a result of the spatial configuration itself. In other words, the evidence provided by the morphological experiments and the modern dwellings are simple reflexes of a more profound characteristic of relational graphs. They are not dependent on the form-function nature of the buildings. The 'graph colouring process' (Steadman, 1983: pp 100-104) used in the experiments is an artificial procedure to encapsulate some basic topological properties under circumstantial boundaries, changeable according to the interest of the researcher. Furthermore, most of the fundamental 'guiding' rules of the sectoring process may also be explained by simple topological laws that regulate distances in graphs. For example, the mediator effect, or the property of mediator spaces in being located at the configurational centre of the studied houses and experimental graphs, may be explained, in the majority of the cases, by its position as cut vertices. This indicates that the mediation effect is, in fact, a 'cut vertex effect'.

Other sectors' guiding rules may also be disputed. The carrier effect follows a simple morphological principle which says that increasing the permeability of a space, and therefore making it shallow from the point of view of the system will invariably make this space particularly central. The more shallow the system is from this space, as a carrier for example, the more integrated it would be. The isolation effect responds to an opposite circumstance, but also of configurational origin. The more isolated or deep a considerable set of spaces is, the spaces which are closer to it will tend to be the locus of integration of the system.

None of the arguments used to explain, or to propose, a general theory on the power of sectoring in guiding the integration pattern of purposeful buildings denies or undermines the morphological properties of graphs. On the contrary, the understanding of these properties is founded on the understanding of how space configuration and function are tied together to construct purposeful buildings. In fact, it is exactly how spatial systems are managed to perform under certain circumstances which corroborates the proposed hypothesis. They exemplify how, consciously or unconsciously, the fundamental laws of space are invoked to shape form into an active field of social and cultural production and reproduction. In this sense, fuzzy or clear boundaries induce the form by which inhabitants, and inhabitants and visitors, should face each other. It is when grouping activities and defining permeability that the laws of space are invoked to give a social logic to the system. Thus, it is the combination of functional requirements, social values and configuration through which spatial systems acquire a sense of social order. Putting in simple words, the sectoring process takes hold of the general laws of configuration to give a socio-functional order to purposeful buildings. This sense of socio-functional order, it is argued, is much in debt to the form taken by the sectors, in such a way that the clearer these sectors are, or the more consistent their forms are, the more regular and consistent the whole building will be. And this functional logic is the key determinant in guiding the depth distribution process.

Chapter Eight
The Three Natures of the Sectors' Paradigm

It is common in research that a topic which was of minor importance when the initial questions were formulated becomes central during the development of the research. The research project which generated this thesis was not initially designed to investigate how certain kinds of domestic activities are spatially tied together to form homogeneous and continuos spatial-functional sectors. The starting point of this research was, in fact, an interest in describing the spatial morphology of modern Brazilian dwellings. It aimed to understand how the diversity of architectural ideas which is normally defined as modernism was used and/or transformed by Brazilian architects, particularly those of Recife, which some experts have suggested as defining a modernist school of architecture (Bruand, 1981: 148).

There were some reasons for designing the research project in these terms. The first of these is because Brazilian modern architecture has been internationally recognised by its individuality and creativity (Goodwin, 1943; Mindlin, 1956; Bruand, 1981) but, the principal reason is its unique interpretation of the modern paradigm of a rupture with history and architectural tradition. Paradoxically, this rupture meant denying the historicist European architectural tradition of the nineteenth century, and then amalgamating modernism with Luso-Brazilian tradition from the colonial period (1500-1822) to create a national cultural identity (Martins, 1987; Telles, 1988; Barros, 1995). Knowing that most of the elements of this colonial tradition were of a formal nature, it was interesting to consider if there was any sort of relationship between the modernist and the colonial spatial structures.

Secondly, although being extensively studied, Brazilian modernity has been approached from a historical and descriptive viewpoint (Goodwin, 1943; Bruand, 1981; Acayaba and Ficher, 1982) or from the history of its ideas (Martins, 1987; Telles, 1988; Bayeux, 1991; Barros, 1995). Only more recently has spatial morphology been of interest of Brazilian scholars, but modern individual dwellings were still to be investigated fully, particularly as far as the relationship between theoretical concepts and architectural design is concerned.

Finally, because the theme of the individual family dwelling was the prevalent modernist theme in Brazil, and it was so extensively and intensively explored throughout the country at various social levels, it became an architectural tradition. The theme of the modernist dwelling seemed to be ideal for an investigation aimed to understand the Brazilian modernist phenomena spatially.

The study was to be based on the application of space syntax techniques to represent and describe the spatial complex of a set of modern dwellings of Recife and understand their main configurational properties. It was believed that, if architects' houses tend not to follow 'conventional' spatial-functional genotypes of ends, it would possibly express spatial signatures through these distinctive spatial properties. In addition, by comparing the modern houses of Recife with contemporary modern houses built in other parts of the country this would answer the question of whether there was a 'true' regional school of architecture in Recife.

However, during the first stages of the research it was perceived that one of the most important characteristics of Brazilian modernist architecture, similar to other modern experiences, was the lack of an analytical theory and a profusion of normative procedures. And amidst these normative procedures, or prescriptive theories of how Brazilian modernist houses should be, organising domestic activities into sectors was to be seen as a central and powerful concept. Noting how pervasive this concept was, this study directed its interest to investigating whether sectoring was as pervasive in building forms as it was in the architectural discourse and architectural education. Surprisingly, as discovered through a pilot study (Amorim, 1995b), the functional sectors were not only clearly expressed in houses' plans, and occasionally by their volumetric compositions, but followed consistent patterns in form of sectors' genotypes. The important outcome from this study was that the modernist concept of domestic sectors moved to the centre of the investigation. Its aim became the understanding of the effects of this paradigmatic idea in the organisation of the modern houses of Recife.

To develop the investigation, an extensive data base on Recife's modern domestic experience was accumulated, containing a substantial review of the small number of published works on local modern architecture, which was complemented by interviews with architects, professors and researchers, and a representative sample of plans, collected from diverse sources such as published material and unpublished and original material collected from public records and architects' private archives.

The proper analysis of the sample was made possible by the creation of a complete set of representational and descriptive techniques. The methodological procedure, called 'sectors' analysis', is based on the representation of houses sectors' structures as a graph, where the sectors are the nodes and the edges are the connections between the diverse domestic zones. The sectors' graph is then analysed configurationally, observing the fundamental properties of depth from the exterior, i.e., the public space, and integration.

8.1. On some findings

The application of this technique allowed the discovery of important phenomena. It proved that the concept of domestic sectors was indeed as pervasive in architectural prescriptive and descriptive texts as in the built form itself. The majority of the modern houses classify and group similar kinds of domestic activities into discrete sectors and organise the domestic complex, in order to keep the unity of the sectors and to sustain an organic structure for the whole. In this sense, the sectors' organisation provides the necessary underlying structure to give logic and functionality to the house.

But as important as the simple identification of the pervasiveness of the sectors' idea in the built form is the fact that, even though the houses present a substantial set of phenotypical arrangements, they present consistent patterns in the form of genotypical sectors' arrangements. These 'sectors' genotypes', identified by the rank order of integration of the sectors and substantiated by other syntactic data, like depth and space-type occurrence, revealed that the modern house should put the social and service sectors at the centre of its configuration and segregate the private and public spaces.

This finding is fundamental because it demonstrates that houses designed by architects can express 'functional genotype of ends' as vernacular houses usually do. This means that underlying the experimental nature of architects' houses, there is a consistent form of assigning activities to space, at least at the level of the sectors organisation of the houses. Therefore, if some architects do present some consistencies in the forms they compose spatially, regardless of the function or activities which are taken in the space complex, they may also present some consistencies in their spatio-functional composition. In this sense, the sectors' functional genotype of ends would provide the basis for the development of 'spatial genotype of means'.

The study shows that these genotypical forms of sectors' arrangements are defined by a set of 'restrictive rules', which specifies from the vast number of possible combinations of sectors, the specific set of arrangements which fit owner's desires, architects' idiosyncrasies and social requirements. The strength of the social requirements in shaping the forms of these 'restrictive rules' suggests that the modern methodological procedure of classifying activities and users into sectors is embedded in a sort of cultural tradition, which sees the need to express social and individual inequalities in the household structure.

The study of colonial and eclectic houses of Recife, dated from the nineteenth century and the first decades of this century, showed that they were similarly arranged into sectors, however of a distinct and different nature and organisation from the ones found in modern dwellings. The pre-modern sectors express more emphatically the social inequalities of the household and preserve more rigorously the isolation of the family from the public life. This result proves that the modernist sectors' genotypes is deeply embedded in cultural and social roots, integrating a normative architectural theory with a long-lasting local tradition.

But, more interestingly, the identification of strong genotypical forms of sectors' arrangements amongst the pre-modern dwellings suggests the need to evaluate the spatial organisation of vernacular houses through the constitution of their domestic territories. It is possible that the sectors' analysis of vernacular houses may reveal interesting spatial patterns and reinforce some of the findings provided by the traditional form of spatial analysis used in the space syntax field.

The importance of the sectors' analysis is that it captures a kind of fundamental or primary layer in the space-function configuration of buildings. Indeed, the definition of precise domestic realms constitutes the 'topological gene' of the house, the basic foundation for the development of house's layout. The 'topological gene' operates in the design process by establishing possible adjacency and permeability between spaces, therefore accomplishing the passage from the infinite realm of architectural possibilities to the finite set of architectural actuality, the set of actual solutions that attend to the constraints imposed by the restrictive rules.

Knowing that the pre-modern and modern houses grouped different domestic activities into different sectors, it came as a surprise that they share some fundamental properties. Colonial, eclectic and modern houses spatialize service activities in similar ways, which demonstrates that expressing social inequalities is one of the key aspects of Recife's houses. Moreover, the spaces for receiving guests remains at the configurational centre of the dwellings, both in the conceptual diagrammatic sectors' graphs and in the space configuration itself. This diachronic study also describes the evolution of Recife's domestic ambience from the strict house of the patriarch to the modern nuclear family dwelling. It shows that the definition and materialisation of the domestic sectors moved from a more flexible spatial configuration, controlled by means of strong social rules of behaviour, to a more static configuration, where space assumes the leading restrictive position once imposed by social laws.

However, perhaps the most important finding of this thesis is the identification of the 'guiding' role of sectors in distributing depth in the spatial structure of the houses. The study shows that the overall configuration of the houses is deeply influenced by definition of clear or fuzzy sectors' boundaries, by the design of sectors to form trees or rings, and by the use of mediation. The power of the sectors' structure is such that it is possible to predict the overall distribution of integration in a given system on the basis of the sectors' arrangement itself. This is a prediction which is not precise, because the exact terms or figures must always be calculated when changes are generated in any given configuration; but even being generic, it is regarded as an essential tool in evaluating the configurational behaviour of spatial complexes while composing it or changing it.

As a design tool, the sectors' analysis may be used to help architects in the first stages of design, mainly in the design of building types in which the classification and separation of different group of activities or categories of users are necessary. Building types such as Courthouses, in which a strict separation of the members of the court of justice - the judge, the jury, the testimonies, the accused, the members of the audience, have to be spatially exercised in order to preserve the integrity of the judiciary process. The building has to devise a way in which all these different categories are to meet each other formally and ceremoniously only in the courtroom.

Still as a design tool, the devised method could also be applied to predict the effects of specific arrangements, and therefore eliminate, in the early stages of design, some undesirable solutions. More importantly, it may also be useful in predicting, in broad terms, the effects that different types of arrangement may generate in the overall configuration of buildings.

8.2. The natures of the sectors' paradigm

In conclusion, it may be said that the domestic sectors phenomenon, as identified and described in this thesis, has a threefold nature. Firstly, a 'methodological nature' which orients architects in the process of selecting actualities in the realm of possibilities; secondly, a 'social nature', which defines the common rules to which designers must attend, either consciously or unconsciously, in order to fit a established cultural environment; and finally a 'spatial nature', which guides the configuration of buildings themselves.

8.2.1. The methodological nature of the sectors' paradigm

The 'methodological nature' of the sectors' paradigm works as a 'primary generator' (Darke, 1979) , i.e., 'a concept or a small group of concepts which serve the architect as a way in to the problem' (Heath, 1984: 125), or a 'paradigmatic typology' (Van Leusen, 1996). In this sense, the possible conjectures for the design problem are developed under the reasonably flexible limits of the sectors, allowing the designer to keep some of the general aspects of the building steady, while developing adequate solutions on a smaller scale, from space to space. This dynamic design process permits the architect to evaluate constantly the results of the proposed solutions by bringing the spatio-functional diagram from the background to be reshaped in the foreground of the design process.

8.2.2. The social nature of the sectors' paradigm

To establish more clearly the social nature of the sectors' paradigm, it is necessary to explore the concept of the oneiric house as proposed by Gaston Bachelard, in his seminal *Poetics of Space* (1969). Bachelard argues that 'there exists for each one of us an oneiric house, a house of dream-memory, that is lost in the shadow beyond the real past' (Bachelard, 1969: 15), and that this very 'oneiric house' is permanently reconstructed in every house we inhabit. Bachelard's poetic dwelling is imagined as a 'vertical being', which rises from the irrationality of the cellar, where all the fears and uncertainties of ones' lives reside, to the rationality of the attic, where light and the views of the world illuminate and dissipate the fears of life. In Bachelard's words, 'we become aware of this dual vertical polarity of a house if we are sufficiently aware of the function of inhabiting to consider it as an imaginary response to the function of constructing', and concludes that the 'dreamer constructs and reconstructs the upper stories and the attic until they are well constructed' (Bachelard, 1969: 18), However, to understand the social nature of the paradigm, this oneiric topology which is supposed to inhabit the memories of all dreamers and daydreamers, has to be reformulated from a distinct point of view. The oneiric topology has to be 'resocialised', instead of 'desocialised' as exercised by Bachelard (1969: pp 8-9). It is proposed that the sectors constitute a set of mental constructions which define not symbolic values, but the very terrain and practical values of social production and reproduction in the dwelling's environment. They are necessary social constructions which allow the daydreamer to subvert its order and reconstruct Bachelard's oneiric house.

For example, in the Brazilian modern nuclear family dwelling, class distinction is determined while segregating servants and establishing the boundaries for social relations; and individual privacy is established to help construct the independence of character of each element of the family. These three fundamental aspects of the modernist house constitute not a vertical oneiric house, but a relational social house. Indeed, instead of imagining the house as a vertical being which ascends from the earth to the sky, from the irrationality of the cellar to the rationality of the attic, the house should be understood as a social topology of the values that bind the family together. It is in the subjective materialisation of these realms that objective social mechanisms are formed. In the same way students learn the social and moral values of their social group in the classroom and develop their skills to deal with the uncertainties of life in the corridors and playground, the organisation of the house in such realms orients the maturing child in understanding the appropriate behaviour towards certain kinds of social relations. Class rated, gender related, racial differentiation, cultural inequalities, individual privacy are all expressed in the spatial organisation of these domestic realms. It is not Bachelard's daydreamer who constructs and reconstructs this social topology, but the social being who daily constructs and reconstructs its very position in the family and in the social group to which he/she belongs.

8.2.3. The spatial nature of the sectors' paradigm

Finally, the spatial nature of the sectors' paradigm is manifested in the forms by which the space configuration is regulated by the generation of meso-spatial-structures within the overall configuration of the houses. The sectors eliminate inconsistencies at the level of the spatio-functional organisation and establish a certain degree of regularity in the configuration of the houses, allowing for consistent predictions of its behaviour according to the types of sectors arrangements used. The sectors are, therefore, a preliminary means to generate consistent spatial patterns, in the form of functional genotype of ends.

In conclusion, the 'social nature' of the sectors define the spatio-functional genotypes of ends that subsist in determined cultures, whereas their 'methodological' nature define their phenotypical arrangements. The 'spatial nature' of the sectors orders its effects in the overall configuration of the buildings, by means of constructing consistent regularities in the unpredictable and irregular world of graphs.

8.3. Further research

This investigation was focused on the modern houses of Recife, designed between the 1940's and the 1970's. The last three decades saw an increasing reduction in the number of designed and built houses in the city. This phenomenon is generally interpreted as a result of the growth of urban violence, the increasing costs of maintaining a house's structure, but mostly by the availability of a safer, more economic and trendy lifestyle offered by flats.

What sort of building is the contemporary house? In what way does it reflect the modernist tradition? In what way has the increase of urban violence changed their features? Are they more enclosed? Are the number of terminal rooms higher than in modernist houses? Did the number of rings within the houses reduce to increase control of access? Is the sectors' paradigm as powerful as it used to be? Is there any new form of sectors' arrangement generated by the absence of the housemaid in most of the households? Is the service sector weaker, less defined? Did the kitchen get closer to the social area, as inhabitants have had to assume some of the daily routine of the housemaids?

In addition to the reduction of the number of housemaids, the structure of the middle and upper class families has substantially changed. Until 1977, date of the legalisation of divorce, marriage was considered to be an indissoluble bond between a man and a woman, both by the State and the Church, therefore preserving the ideal modern nuclear family as the basis of Brazilian society. What is seen today is the increasing number of restructured families, composed of the original nuclear family, however disintegrated, and a new form of extended family composed of half-parents, half-brothers and half-sisters, bringing a more dynamic relationship to the household structure never seen before in Brazilian society, almost never in the middle and upper classes.

This more dynamic relationship is restructuring the concept of house or home in people's minds. The house is no longer the place in which the family realises itself, but it is the split or doubled structure in which children construct their relationships with their mothers and fathers separately, and vice-versa. How have the new houses responded to these changes? Is there any evidence of the restructure of the family in the configuration of the contemporary house, as seen when the patriarchal family was slowly restructured to assume the nuclear family composition? Or are the houses still thought of as housing a nuclear family in order to sustain the moral values prevalent in the previous decades?

Another aspects which has to be remembered is the proliferation of domestic appliances in the household structure which have transformed the bedrooms into a self-contained unit, as if the dwelling were composed of independent compartments in which each member of the family would have their private and exclusive world. The living room as a space for interacting, and more importantly, for the realisation of the family has, it seems, lost its power. Is this a new form of family co-habitation related to the reshaped family structure? Is this higher degree of individuality the expression of our time?

Parallel to these questions runs the proper history of the apartment or flat as a substitution for the individual family dwelling. Curiously, Vauthier commented in 1840, that unrelated families living in the same building was not socially recommended. Today, the multi-familial tower blocks are not only more popular, but in some circumstances can increase the status of the family.

All these questions establish a new chapter in the evolution of the domestic buildings of Recife. It is hoped that some of the findings achieved in this thesis may shed light upon how the more recent changes in the housing configuration have occurred and why. Future research projects might consider the continuing changes in society and how these changes may affect the way in which we live, in preparing for the new architectural and spatial designs for the future.

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APPENDICES

APPENDIX ONE

GLOSSARY OF TERMS AND EXPRESSIONS

accessibility is the property of spatial systems in been permeable to access and movement.

axial line is the longest line of sight and access which pass through the maximum number of convex spaces

axial map is the discrete set of 'longest and fewest' axial lines which pass through every convex space of a given spatial system.

boundary effect is found in closed bounded sectors symmetrically composed and establishes the centre of integration in the boundaries between the sectors, regardless of their internal structure. Therefore, the clearer the boundaries of the sectors are, the more the integration core would tend to move towards their boundaries.

bounded space, is a room which corresponds to a single convex space which can be isolated from the spatial system by means of doors and walls.

bounded-convex ratio expresses how open or compartmentalised a layout is. It is expressed by the equation,

$$BC = \frac{b}{c},$$

where BC stands for bounded-convex ratio, b for the number of bounded spaces and c for the number of convex spaces. Systems with high 'bounded-convex ratio' are more compartmentalised, whereas systems which present low values are more convexialy articulated.

buffer zone or **space**, see mediator sector or space

carrier effect means the ability of the carrier space to drag integration towards itself when its connectivity is increased, regardless of the configurational properties of the sectors.

carrier space, is the continuos and infinite space which 'contains' or surrounds a finite spatial system.

clear boundary of a sector occurs when the connectivity of the sector is very low, therefore a sector is not precisely defined.

cognitive value is the correlation between integration and visual integration of a given system. High correlation values indicate spatial systems in which the information available within the system is directly proportional to the relative position of each space unit in the configuration, whereas low correlation values express how irregular accessibility and visibility are distributed in the system.

configuration is understood, according to Hillier (1996: 1) as relations taking into account other relations.

connectivity expresses the number of visual or permeable links each spatial unit or sector has.

convex isovist represent the visible area from all discrete points of a convex space (see *isovist*).

convex map is the least set of fattest and fewest convex spaces in a space configuration.

convex space, is defined when 'straight lines can be drawn from any point in the space to any other point in the space without going outside the boundary of the space itself' (Hillier and Hanson, 1984: pp 97-98).

convexiality, see topological size.

degree of functionality is the ratio between the number of use related spaces and the total number of spaces, expressed by the equation:

$$DF = \frac{f}{c},$$

where DF stands for degree of functionality, f for the number of functional spaces, and c for the total number of convex spaces. Low values indicate a 'transitional oriented' plan, whereas high values indicate a 'functional oriented' layout.

degree of permeability expresses the connectivity of each sector relativised by its total number of spaces, as seen in the equation:

$$DP = \frac{sc - 1}{n},$$

where DP stands for degree of permeability; sc for sectors' connectivity; and n for the number of spaces. When the connectivity is equal to 1, the degree of permeability is said to be 0, as it represents the minimal possible connectivity.

depth is the distance, or number of edges, from one node to another in a graph

difference factor is an entropy based measure which quantifies the degree of differentiation amongst integration values, as expressed in the equation (Hillier, Hanson et al., 1987: 365):

$$H = -\Sigma\left[\frac{a}{t}\ln\left(\frac{a}{t}\right)\right] + \left[\frac{b}{t}\ln\left(\frac{b}{t}\right)\right] + \left[\frac{c}{t}\ln\left(\frac{c}{t}\right)\right]$$

where H is the unrelativised difference factor for three spaces, a, b, and c are the integration values of the spaces and t is their sum. The H value can be 'relativised' between *ln2* and *ln3* to give a 'relative difference factor' H^*,

$$H^* = \frac{H - \ln 2}{\ln 3 - \ln 2}$$

which value vary between 0 (the maximum difference, or minimum entropy) and 1 (the minimum difference or maximum entropy, that is all values are equal).

difference value is an alternative method for quantifying configurational differences. It is valuable to measure sets of numbers which include 0. It expresses the ratio between the sum of the differences between values, over the average of these values:

$$DV = \frac{\{[n-(n-1)]...+(c-b)+(b-a)\}}{\left\{\frac{[n-(n-1)]+...+c+b+a)}{n}\right\}}$$

where DV stands for difference value, and a, b, c ... n stand for the actual values to be compared.

façade isovist represent the visible area from a given façade (see *isovist*).

fuzzy boundary of a sector occurs when the connectivity of the sector is very high, therefore the sector is not clearly defined.

genotype or **spatial-functional genotype** is defined 'in terms of relational and configurational consistencies which show themselves under different 'phenotypical' arrangements' (Hillier, Hanson and Graham, 1987: 379). Therefore, when consistencies in the way functions are assigned to space are found amongst a sample of buildings, it is said that a genotype is present - a spatial-functional genotype of ends.

genotype of ends (see genotype)

genotype of means are found when spatial properties are held consistent within a sample of buildings designed by an architect, regardless of the functions assigned to space.

integration core, represents the set of most integrated spaces of a given configuration. There are different methods to define the composition of the core but it is mostly found in the literature as composed of 10 to 25% of the total number of spatial components of the configuration.

integration expresses the relative distance from one space to all spaces in a configuration. It is expressed by the RA (relative asymmetry) and RRA (real relative asymmetry) values. The first is used to compare spatial systems of similar sizes, whereas the second is used for different sized systems. (see relative asymmetry and real relative asymmetry).

isolation effect induces, in systems composed by highly permeable and highly enclosed sectors, the position of the integration core towards an eccentric position closer to clear bounded sector.

isovist, or **point isovist**, represent the visible area from a discrete point in space.

joker effect represents the property of mediator sectors in assuming different positions in the sectors' graphs.

justified graph represents the accessibility properties of a spatial system rooted or 'justified' from a given space or spaces.

line isovist represent the visible area from all discrete points of an axial line (see *isovist*).

maximum connectiveness, is the maximum number of connections in a system of a given number, calculated by the expression:

$$MC = 3p - 6$$

where MC stands for maximum connectiveness and p for the number of points or nodes in the graph.

mean depth expresses the distance from one node to all nodes in a graph

mediation effect is the property of mediator spaces in being located at the configurational centre of spatial complexes.

mediator space or **sector** has the role of mediating the accessibility amongst differentiated spaces or sectors.

minimum living complex, is the least continuous interior set of convex spaces which form the house.

permeability, see accessibility

phenotype, is a set of observable characteristics of a building, or buildings, as determined by its space genotype and other environment determinants.

rank order of integration, sorts the spatial units of a given system according to their integration value. An important procedure to identify space genotypes (see genotype).

real relative asymmetry converts the relative asymmetry (RA) value in order to allow comparative studies of spatial systems with different sizes. The transformation is done by comparing the RA value of a given space with the RA value for the root of a diamond-shaped system of the same size (Hillier and Hanson, 1984: 113),

$$RRA = \frac{RA}{d},$$

where *RRA* stands for Real Relative Asymmetry, *RA* stands for Relative Asymmetry and *d* stands for d-value, which is calculated by the equation (Peponis, Wineman et al., 1997: 771),

$$d = \frac{6.644k\lg(k+2) - 5.17k + 2}{k^2 - 3k + 2},$$

where *d* stands for d-value and *k* for the number of spaces in the system.

relative asymmetry represents the relative distance of one space to all spaces of a given system. It is calculated by the expression (Hillier and Hanson, 1984: 108),

$$RA = \frac{2(MD-1)}{k-2},$$

where *RA* stands for Relative Asymmetry, *MD* to mean depth and *k* to the total number of spaces in the system.

relative connectiveness expresses the degree of ringiness of a spatial system relativised to the maximum possible connectivity value of a system of the same size, according to the expression:

$$RC = \frac{c-(p-1)}{2p-5},$$

where RC stands for relative connectiveness; c for the number of connections in the complex; and p its number of points. The RC values range from 0, a tree-like graph, to 1, maximum possible ringiness in the graph.

relative ringiness is the number of distinct rings relatively to the maximum possible planar rings for a given system, expressed as (Hillier and Hanson, 1984: 154)

$$RR = \frac{r}{2p-5}$$

where RR is the value of relative ringiness; r the number of rings in the complex; and p its number of points or nodes in the graph. The RR values will range from 1, maximum degree of ringiness, to 0, a tree. Relative ringiness and relative connectiveness are different expressions to represent the same phenomenon. The first takes into account the number or rings in a graph, while the second counts its connectivity value.

ring or **cycle** is a 'continuous sequence of vertices and edges, containing at least three vertices, which does not double back on or intersect itself, and which returns to the original vertex' (Steadman, 1983: 90).

sectors' analysis is a representational and analytical procedure which pictures the functional organisation of buildings.

sectors' genotype occurs when configurational consistencies are found amongst sets of sectors' graphs

sectors' paradigm establishes the prevalence of classifying and grouping similar activities into zones or sectors in design process.

sectors, or **zones**, are sets of spaces which share similar or complementary activities.

space types are configurational descriptions of spaces which takes into account their number of connections and relative position in graphs. There are, according to Hillier (1996), four topological types of space: a-type space has one link; b-type has more than one connection and lies on a tree; c-type has more than one connection and lies on a ring; and d-type space has more than two connections and lies at least in two rings.

space type profile is a graph which plots the space-ness values of a given spatial system.

space-link ratio, expresses the degree of ringiness of a configuration and it is calculated with the use of the following expression (Hillier, Hanson et al., 1987: 373)

$$SL = \frac{l-1}{s}$$

where SL stands for space-link ratio, l for the number of links and s the number of spaces of a given system.

space-ness value indicates the degree of occurrence of a given space-type in a spatial system in relation to its maximum possible occurrence in a system of the same size. The space-ness value is calculated through the following expressions:

$a\text{-}ness = a / n - 1$

$b\text{-}ness = b / n - 2$

$c\text{-}ness = c / n$

$d\text{-}ness = d / n$

where a, b, c and d stand for the number of space types and n the total number of spaces of the system.

topological gene represents

topological size is the number of nodes of a graph.

tree is a graph with no rings or cycles.

visual field, see *isovist*

Table A.2.1. Recife architects' houses: rank order of integration (inside)

Amorim	15 Hallst < 0.9180	13 Stairs1 < 0.9769	4 Vestibule < 1.0593	24 Passage2 < 1.0710	16 HMbed < 1.1652	17 Bwc1 < 1.2005	5 Dining < 1.2358	23 Bed < 1.2829	28 Stairs2 < 1.3182	1 Hall < 1.3770	26 Terrace2 < 1.4006	25 Terrace1 < 1.4123	14 Space < 1.4241	19 Mbed1 < 1.4594	8 Passage1 < 1.5300	18 Bwc2 < 1.5653	29 Passage3 < 1.5889
	6 Living1 < 1.6007	2 HOffice < 1.7184	27 Terrace3 < 1.7654	21 Mbed2 < 1.8007	9 Kitchen = 1.8243	20 Boudoir < 1.8243	30 RoofGrd1 < 1.8831	7 Living2 < 1.9655	3 Office < 2.0832	11 Sbed = 2.1656	22 MBTerrace < 2.1656	10 Storage < 2.1891	31 RoofGrd2 < 2.2009	12 SBwc < 2.5305	32 RoofGrd < 2.5422	33 RoofGrd4 2.9071	
Reynaldo	9 Passage < 0.9873	12 Corridor1 < 1.0392	2 Dining < 1.0912	13 Corridor2 < 1.1431	4 HStairs < 1.3510	HKitchen < 1.4029	17 HMbed < 1.4289	1 Living = 1.5069	15 Bed 2 < 1.5069	14 Bed 1 = 1.6108	16 Bwc < 1.6108	5 Stairs < 1.6628	18 Mbed < 1.7926	11 Kitchen < 1.8706	3 Space < 1.9745	6 Office1 = 2.0525	7 Office2 < 2.0525
	19 Garage1 < 2.2083	8 Veranda < 2.4941	20 Garage 2 2.676														
Borsoi	10 Office = 1.2444	12 Ramp < 1.2444	13 Hall < 1.2888	9 Stairs < 1.3333	1 Living1 < 1.4666	16 Bed2 = 1.5111	17 Corridor2 < 1.5111	2 Dining = 1.6888	11 Library < 1.6888	14 Bwc = 1.7333	15 Bed1 = 1.7333	18 Lavatory < 1.7333	3 Living2 < 1.9111	4 Corridor1 < 1.9555	19 Passage = 2.0888	20 Mbed < 2.0888	6 Copa < 2.3111
	5 Toilet < 2.3999	21 MBbwc = 2.5333	22 Closet < 2.5333	7 Kitchen = 2.7555	8 Storage 2.7555												
Esteves	7 Hall < 0.6829	6 Stairs = 0.8346	11 Corridor2 < 0.8346	3 Corridor1 < 1.0622	13 Corridor3 < 1.1381	8 Veranda = 1.2139	9 Cloth Clst = 1.2139	10 Bed1 < 1.2139	12 Bed2 < 1.3657	2 Dining < 1.5174	4 Kitchen = 1.5933	5 Toilet < 1.5933	14 Bwc = 1.6692	15 Bed3 = 1.6692	16 Bed4 < 1.6692	1 Living 2.0486	
Domingues	9 Passage2 < 1.1318	11 Passage3 < 1.1601	5 Copa < 1.2167	13 Closet < 1.3016	14 Mbed < 1.4997	4 Dining < 1.5280	10 Garage < 1.6129	7 Kitchen1 = 1.6412	12 Bwc < 1.6412	6 Passage1 < 1.6978	15 Bed1 < 1.7544	2 Living1 < 1.8958	16 Passage4 < 2.0656	8 Kitchen2 < 2.1222	1 Hall = 2.3769	3 Living2 < 2.3769	18 Bed2 < 2.4900
	17 ChldrBwc < 2.5466	19 Office 2.9711															
Campello	6 Corridor1 = 0.6247	9 Corridor2 < 0.6247	4 Dining = 0.8169	7 Passage < 0.8169	11 Lavatory < 1.1052	3 Living = 1.2013	10 Mbed = 1.2013	13 Bed1 = 1.2013	14 Bed2 < 1.2013	5 Kitchen = 1.3935	8 Closet < 1.3935	12 Bwc < 1.6818	1 Vestibule = 1.7298	2 Office 1.7298			
Svenson	5 Corridor < 0.3829	1 liv/dining < 0.6382	11 Corridor2 < 0.8296	10 Mbed < 0.8935	2 Passage = 1.0211	6 Bwc = 1.0211	7 Sbed = 1.0211	8 Living2 = 1.0211	9 Bed1 < 1.0211	12 MBbwc < 1.4679	3 Kitchen = 1.5955	4 Laundry 1.5955					
Pontual	2 Passage1 < 1.0754	3 Corridor < 1.1374	13 Living < 1.2615	1 Vestibule < 1.3442	7 HMbed < 1.3649	14 Dining < 1.4890	4 Bed1 = 1.5717	5 Bwc = 1.5717	6 Bed2 < 1.5717	8 Office < 1.6337	20 Stairs < 1.6544	15 Kitchen < 1.7578	9 Mbed < 1.9439	21 Passage < 2.0060	16 Passage2 < 2.0680	11 MBbwc1 < 2.3368	10 Closet < 2.3782
	22 Hall < 2.3989	17 Laundry = 2.4196	12 MBbwc2 < 2.7711	23 Space < 2.8332	18 Sbwc = 2.8538	19 Sbed 2.8538											

Table A.2.2. Recife architects' houses: rank order of visual integration (inside)

Amorim	13 Stairs1 0.165	<	15 Hallst 0.235	<	28 stairs2 0.306	<	8 passage1 0.318	<	9 kitchen 0.330	=	17 bwc1 0.330	=	24 passage2 0.330	<	19 Mbed 1 0.341	=	27 terrace3 0.341	<	14 space 0.353	=	21 Mbed 2 0.353	=	26 terrace2 0.353	<	16 HMbed 0.365	=	25 terrace1 0.365	<	1 hall 0.377	=	5 dining 0.377	=	6 living1 0.377	<	4 vestibule 0.388	<
	11 Sbed 0.424	<	18 bwc2 0.436	<	23 bed 0.541	<	29 passage3 0.577	=	30 Roofgrd1 0.577	=	33 Roofgrd4 0.577	<	31 Roofgrd2 0.589	<	2 Hoffice 0.600	<	20 boudoir 0.647	<	7 living2 0.659	<	10 storage 0.683	=	12 Sbwc 0.683	<	22 Mbterrace 0.694	<	3 office 0.730	<	32 Roofgrd3 0.836									
Reynaldo	9 passage 0.260	<	12 corridor1 0.312	<	13 corridor2 0.338	<	2 dining 0.416	<	4 Hstairs 0.442	=	5 stairs 0.442	<	6 office1 0.494	=	15 bed 2 0.494	<	10 Hkitchen 0.546	<	1 living 0.572	=	7 office2 0.572	=	14 bed 1 0.572	<	3 space 0.598	<	18 Mbed 0.624	<	16 bwc 0.650	=	17 HMbed 0.650	<	11 kitchen 0.702	<	8 veranda 0.779	<
	19 garage1 1.065	=	20 garage 2 1.065																																	
Borsoi	9 stairs 0.244	<	3 living2 0.267	=	10 office 0.267	<	11 library 0.289	=	12 ramp 0.289	<	17 corridor2 0.333	<	1 living1 0.356	<	16 bed2 0.378	<	2 dining 0.422	=	13 hall 0.422	=	18 toilet 0.422	<	14 bwc1 0.467	=	15 bed1 0.467	<	19 passage 0.622	=	20 Mbed 0.622	<	21 bwc 2 0.644	<	4 corridor 1 0.689	=	6 copa 0.689	=
	7 kitchen 0.689	<	5 toilet 0.756	<	22 closet 1.022	<	8 storage 1.111																													
Esteves	6 stairs 0.076	<	11 corridor2 0.190	<	8 veranda 0.228	=	13 corridor3 0.228	<	7 hall 0.266	=	16 bed4 0.266	<	9 cloth clst 0.304	=	12 bed2 0.304	<	10 bed1 0.417	<	3 corridor1 0.455	=	5 toilet 0.455	<	1 living 0.493	=	2 dining 0.493	<	4 kitchen 0.531	<	14 bwc 0.569	=	15 bed3 0.569							
Domingues	9 passage2 0.113	=	13 closet 0.113	<	11 passage3 0.142	<	5 copa 0.198	<	4 dining 0.255	<	2 living 1 0.283	=	14 Mbed 0.283	=	15 bed 1 0.283	<	7 kitchen1 0.311	<	1 hall 0.340	=	3 living2 0.340	<	10 garage 0.424	=	12 bwc1 0.424	=	16 passage4 0.424	=	18 bed2 0.424	<	19 office 0.424	<	6 passage1 0.481	<	8 kitchen2 0.509	<
	17 bwc 2 0.679																																			
Campello	9 corridor 2 0.144	<	4 dining 0.336	<	6 corridor 1 0.384	<	5 kitchen 0.433	<	7 passage 0.625	=	8 closet 0.625	<	11 lavatory 0.673	=	12 bwc 0.673	=	13 bed 1 0.673	=	14 bed 2 0.673	<	10 Mbed 0.721	<	3 living 0.769	<	1 vestibule 0.817	=	2 office 0.817											
Svenson	5 corridor 0.000	<	1 liv/dining 0.128	<	10 Mbed 0.255	<	8 living2 0.319	<	2 passage 0.383	=	3 kitchen 0.383	=	9 bed1 0.383	=	11 corridor1 0.383	=	12 bwc1 0.383	<	4 laundry 0.447	<	6 bwc 0.574	=	7 Sbed 0.574															
Pontual	2 passage1 0.372	<	3 corridor 0.393	=	14 dining 0.393	<	1 vestibule 0.414	<	20 stairs 0.434	<	13 living 0.476	<	7 HMbed 0.517	<	4 bed1 0.579	=	5 bwc 0.579	=	6 bed2 0.579	=	8 office 0.579	=	22 hall 0.579	<	15 kitchen 0.662	=	21 passage3 0.682	<	9 Sbed 0.807	<	10 closet 0.931	<	23 space 1.013	<	16 passage2 1.034	=
	17 laundry 1.034	<	18 Sbath 1.055	=	19 Sbed 1.055	<	11 Mbwc1 1.199	<	12 Mbwc2 1.220																											

Table A.2.3. Recife architects' houses: rank order of integration (the whole complex)

Amorim	4 Vestibule < 0.9118	13 Stairs < 0.9283	15 Hallst < 0.9611	1 Hall = 1.0597	5 Dining < 1.0597	24 Passage2 < 1.1419	16 HMbed < 1.2076	6 Living1 = 1.2240	34 Entrance < 1.2240	17 Bwc1 < 1.2322	14 Space < 1.2240	23 Bed < 1.2404	8 Passage1 < 1.2897	2 HOffice = 1.3719	37 SouthVrnd < 1.3719	28 Stairs2 < 1.3883	39 Southgrd < 1.4212	26 Terrace2 < 1.4458	25 Terrace1 < 1.4540	19 Mbed1 < 1.4869	40 Eastgrd < 1.4951	35 EastVrnd < 1.5033
	7 Living2 < 1.5526	18 Bwc2 < 1.5608	9 Kitchen < 1.6019	38 Westgrd < 1.6347	29 Passage3 < 1.6512	3 Office < 1.7005	41 Northgrd < 1.7087	36 NorthVrnd < 1.7169	42 *EXT* < *1.7498*	27 Terrace3 < 1.7744	21 Mbed2 < 1.7990	20 Boudoir < 1.8155	11 Sbed < 1.9141	10 Storage = 1.9305	30 Roofgrd1 < 1.9305	22 MBTerrace < 2.1276	31 RoofGrd2 < 2.2262	12 SBwc < 2.2427	32 Roofgrd3 < 2.5384	33 Roofgrd4 2.8670		
Reynaldo	9 Passage < 0.8775	2 Dining < 0.8887	28 Laundry < 0.9337	10 Hkitchen < 0.9450	1 Living = 0.9900	25 Terrace < 0.9900	29 Service < 1.0237	19 Garage1 = 1.0462	23 EastGrd < 1.0462	26 Northgrd = 1.0687	27 Oitão < 1.0687	12 Corridor1 < 1.0800	31 SEntrace < 1.1025	20 Garage2 < 1.1137	4 Hstairs < 1.1587	30 Quintal < 1.1700	13 Corridor2 < 1.1812	18 Mbed < 1.1925	17 HMbed < 1.2150	24 Grd < 1.2487	11 Kitchen = 1.3050	3 Space < 1.3500
	21 SBed = 1.3837	22 SBwc = 1.3837	33 ExtMed < 1.3837	15 Bed2 < 1.3950	34 *Ext* < *1.4400*	5 Stairs < 1.4512	32 Backyard < 1.4625	14 Bed1 = 1.5412	16 Bwc < 1.5412	6 Office1 = 1.7775	7 Office2 < 1.7775	8 Veranda 2.1262										
Borsoi	1 Living1 < 0.8730	35 MEntrance < 0.9524	9 Stairs < 0.9921	36 Oitão < 1.0159	31 Terrace < 1.0318	28 Eastgrd1 < 1.0556	2 Dining < 1.0952	3 Living2 < 1.1032	10 Office = 1.1270	37 Passage3 < 1.1270	34 Passage2 < 1.1349	30 Eastgrd3 = 1.1429	38 Quintal < 1.1429	4 Corridor1 = 1.2064	24 Garage < 1.2064	6 Copa < 1.2381	33 Southgrd2 < 1.2460	32 Southgrd1 < 1.2540	39 Corridor4 < 1.2778	12 Ramp < 1.2937	29 Eastgrd2 = 1.3333	42 ExtMed2 < 1.3333
	40 HServ < 1.4206	11 Library < 1.4524	41 ExtMed1 < 1.4683	13 Hall < 1.4762	5 Toilet < 1.5318	7 Kitchen = 1.5635	8 Stairs = 1.5635	43 EXT < 1.5635	23 Laundry < 1.6032	16 Bed2 = 1.7222	17 Corridor2 < 1.7222	25 Sbed1 = 1.7460	26 Sbwc = 1.7460	27 Sbed2 < 1.7460	14 Bwc = 1.8016	15 Bed1 < 1.8016	18 Toilet < 1.9683	19 Passage1 = 2.2619	20 Mbed < 2.2619	21 MBbwc = 2.5873	22 Closet 2.5873	
Esteves	3 Corridor1 < 0.9181	6 Stairs < 1.0185	4 Kitchen < 1.0472	2 Dining < 1.1333	7 Hall < 1.1476	24 Backyard < 1.1763	5 Toilet < 1.3054	1 Living < 1.3341	25 Oitao < 1.3628	17 Garage < 1.3771	11 Corridor2 < 1.3915	22 Northgrd < 1.4776	20 Entrance < 1.4919	28 SEntrance < 1.5063	8 Veranda = 1.5349	9 ClothClst = 1.5349	10 Bed1 < 1.5349	27 Passage = 1.5493	21 Westgrd < 1.5923	13 Corridor3 = 1.6927	26 Hservice < 1.6927	29 EXT < 1.7214
	12 Bed2 < 1.7788	23 Eastgrd < 1.8649	14 Bwc = 2.0801	15 Bed3 = 2.0801	16 Bed4 = 2.0801	18 Sbed = 2.0801	19 Sbwc 2.0801															
Domingues	5 Copa < 0.8461	9 Passage2 < 0.8708	10 Garage < 0.8954	4 Dining < 0.9036	24 Veranda1 < 0.9283	25 Veranda2 < 0.9694	2 Living1 < 0.9776	6 Passage1 = 1.0022	34 Parking < 1.0022	7 Kitchem < 1.0515	11 Passage3 < 1.0761	33 Oitao < 1.1254	1 Hall < 1.1419	14 Mbed < 1.1501	26 Stair1 < 1.1583	35 Quintal < 1.1665	8 Kichen2 < 1.1747	13 Closet < 1.1829	22 Laundry < 1.1994	15 Bed1 < 1.2322	38 Terrace < 1.2404	18 Bed 2 < 1.2569
	19 Office = 1.2733	20 Sbwc = 1.2733	36 Passage6 = 1.2733	37 Westgrd < 1.2733	42 *EXT* < *1.2815*	3 Living2 < 1.3062	32 Stair2 < 1.3555	23 Passage5 < 1.3719	27 Patio1 < 1.3883	12 Bwc1 < 1.4047	31 Patio2 = 1.5115	41 Entrance1 < 1.5115	16 Passage4 = 1.5197	28 Piloti1 < 1.5197	29 Piloti2 = 1.5526	39 Entrance2 < 1.5526	40 Stair3 < 1.6183	21 Sbed < 1.7005	17 Bwc2 < 1.8483	30 Storage 1.8812		
Campello	4 Dining < 0.7537	5 Kitchen < 0.8437	6 Corridor1 = 0.8775	24 Terrace < 0.8775	3 Living < 0.9000	29 SCorridor < 0.9337	25 Passage2 < 1.0350	1 Vestibule < 1.0462	2 Office < 1.0687	23 Pateo2 < 1.0800	7 Passage1 < 1.1025	9 Corridor2 = 1.1250	28 Frontgrd3 < 1.1250	26 Entrance < 1.1362	30 Quintal < 1.1475	22 Pateo1 < 1.1587	27 Frontgrd2 < 1.2262	31 Laundry < 1.3162	19 Garage < 1.3387	15 Toilet < 1.3950	33 Access < 1.4287	8 Cloth Clst = 1.4625
	11 Lavatory < 1.4625	10 Mbed = 1.4850	13 Bed1 = 1.4850	14 Bed2 = 1.4850	32 Frontgrd1 < 1.4850	20 Backgrd1 = 1.5075	21 Backgrd2 < 1.5075	16 Sbed = 1.6762	17 Storage = 1.6762	18 Sbwc < 1.6762	12 Bwc < 1.8225	34 *EXT* *1.845*										
Svenson	5 Corridor1 < 0.4315	1 Liv/dining < 0.5274	16 Patio < 0.5514	7 Sbed < 0.6713	10 Mbed < 0.7432	11 Corridor2 = 0.7672	15 Terrace < 0.7672	8 Living2 = 0.7911	9 Bed1 < 0.7911	2 Passage = 0.8391	13 Quintal < 0.8391	17 Oitao1 < 0.8631	6 Bwc < 0.8870	14 Westgrd = 1.0069	19 Bedterrace < 1.0069	18 Eastgrd < 1.0309	4 Laundry < 1.0788	20 Oitao2 < 1.1028	3 Kitchen < 1.1747	12 MBbwc < 1.2227	21 *EXT* *1.4624*	
Pontual	28 Terrace1 < 1.0652	27 Pergola < 1.1354	22 Hall < 1.1417	41 Service1 < 1.1673	48 Stairs3 < 1.1928	21 Passage3 < 1.2183	17 Laundry < 1.2566	35 NorthGrd < 1.2629	36 Parking < 1.2757	20 Stairs1 = 1.2821	29 Terrace2 < 1.2821	1 Vestibule < 1.2948	47 Quintal3 < 1.3012	2 Passage 1 < 1.3203	16 Passage 2 < 1.3331	49 Ext med < 1.3522	13 Living = 1.3905	40 Passage5 < 1.3905	15 Kitchen < 1.3969	30 Terrace3 < 1.4160	14 Dining < 1.4224	37 Entrance < 1.4288
	43 Passage6 < 1.4288	44 Quintal1 < 1.4415	23 Space = 1.4479	42 Passage5 < 1.4479	31 Terrace4 < 1.4607	24 Shower > 1.4734	34 EastGrd > 1.4862	38 passage4 < 1.4926	39 Stairs2 < 1.5053	3 Corridor < 1.5117	33 SouthGrd < 1.5308	18 Sbath = 1.5627	19 Sbed < 1.5627	46 Quintal2 < 1.6074	50 *Ext* < *1.6584*	32 Passage3 < 1.6967	45 Service2 < 1.7349	7 HMbed < 1.7541	4 Bed1 = 1.8179	5 Bwc = 1.8179	6 Bed2 < 1.8179	25 Toilet < 2.0028
	8 Office < 2.0092	26 Sbed2 < 2.0411	9 Mbed < 2.2771	11 MBBwc1 < 2.5705	10 Closet < 2.5833	12 MBBwc2 2.8767																

Table A.2.4. Recife architects' houses: rank order of integration of the outside spaces (the whole complex)

Amorim	34 Entrance 1.224	< 37 SouthVrnd 1.3719	< 39 Southgrd 1.4212	< 40 Eastgrd 1.4951	< 35 EastVrnd 1 5033	< 38 Westgrd 1.6347	< 41 Northgrd 1.7087	< 36 NorthVrnd 1.7169	< 42 EXT 1.7498									
Reynaldo	28 Laundry 0.9337	< 25 Terrace 0.9900	< 29 Service 1.0237	< 23 EastGrd 1.0462	< 26 Northgrd 1.0687	= 27 Oitão 1.0687	< 31 SEntrace 1.1025	< 30 Quintal 1.1700	< 24 Grd 1.2487	< 33 ExtMed 1.3837	< 34 Ext 1.4400	< 32 Backyard 1.4625						
Borsoi	35 MEntrance 0.9524	< 36 Oitão 1.0159	< 31 Terrace 1.0318	< 28 Eastgrd1 1.0556	< 37 Passage3 1.127	< 34 Passage2 1.1349	< 30 Eastgrd3 1.1429	= 38 Quintal 1.1429	< 33 Southgrd2 1.2460	< 32 Southgrd1 1.2540	< 39 Corridor4 1.2778	< 29 Eastgrd2 1.3333	= 42 ExtMed2 1.3333	< 40 HServ 1.4206	< 41 ExtMed1 1.4683	< 43 EXT 1.5635		
Esteves	24 Backyard 1.1763	< 25 Oitao 1.3628	< 22 Northgrd 1 4776	< 20 Entrance 1.4919	< 28 SEntrance 1.5063	< 27 Passage 1.5493	< 21 Westgrd 1.5923	< 26 Hservice 1.6927	< 29 EXT 1.7214	< 23 Eastgrd 1.8649								
Domingues	24 Veranda1 0.9283	< 25 Veranda2 0.9694	< 34 Parking 1.0022	< 33 Oitao 1.1254	< 26 Stair1 1.1583	< 35 Quintal 1.1665	< 22 Laundry 1.1994	< 38 Terrace 1.2404	< 36 Passage6 1.2733	= 37 Westgrd 1.2733	< 42 EXT 1.2815	< 32 Stair2 1.3555	< 23 Passage5 1.3719	< 27 Patio1 1.3883	< 31 Patio2 1.5115	= 41 Entrance1 1.5115	< 28 Piloti1 1.5197	< 29 Piloti2 1.5526
	39 Entrance2 1.5526	< 40 Stair3 1.6183																
Campello	24 Terrace 0.8775	< 29 SCorridor 0.9337	< 25 Passage2 1.0350	< 23 Pateo2 1.0800	< 28 Frontgrd3 1.1250	< 26 Entrance 1.1362	< 30 Quintal 1.1475	< 22 Pateo1 1.1587	< 27 Frontgrd2 1.2262	< 31 Laundry 1.3162	< 33 Access 1.4287	< 32 Frontgrd1 1.485	< 20 Backgrd1 1.5075	= 21 Backgrd2 1.5075	< 34 EXT 1.845			
Svenson	16 Patio 0.5514	< 15 Terrace 0 7672	< 13 Quintal 0.8391	< 17 Oitao1 0.8631	< 14 Westgrd 1.0069	= 19 Bedterrace 1.0069	< 18 Eastgrd 1.0309	< 20 Oitao2 1.1028	< 21 EXT 1.4624									
Pontual	28 Terrace1 1.0652	< 27 Pergola 1.1354	< 41 Service1 1.1673	< 48 Stairs3 1.1928	< 35 NorthGrd 1.2629	< 36 Parking 1.2757	< 29 Terrace2 1.2821	< 47 Quintal3 1.3012	< 49 Ext med 1.3522	< 40 Passage5 1.3905	< 30 Terrace3 1.4160	< 37 Entrance 1.4288	< 43 Passage6 1.4288	< 44 Quintal1 1.4415	< 42 Passage5 1.4479	< 31 Terrace4 1.4607	< 34 EastGrd 1 4862	< 38 passage4 1.4926 <
	39 Stairs2 1.5053	< 33 SouthGrd 1.5308	< 46 Quintal2 1.6074	< 50 Ext 1.6584	< 32 Passage3 1.6967	< 45 Service2 1.7349												

The service spaces are highlighted in bold

Table A.2.5. Recife architects' houses: rank order of integration of the inside spaces (the whole complex)

Amorim	4 Vestibule < 0.9118	13 Stairs < 0.9283	15 Halhst < 0 9611	1 Hall = 1.0597	5 Dining < 1.0597	24 Passage2 < 1.1419	16 HMbed < 1.2076	6 Living1 < 1.2240	17 Bwc1 < 1.2322	14 Space < 1.2240	23 Bed < 1.2404	8 Passage1 < 1.2897	2 HOffice < 1.3719	28 Stairs2 < 1.3883	26 Terrace2 < 1.4458	25 Terrace1 < 1.4540	19 Mbedh < 1.4869	7 Living2 < 1.5526	18 Bwc2 < 1.5608
	9 Kitchen < 1.6019	29 Passage3 < 1.6512	3 Office < 1.7005	42 *EXT* < *1.7498*	27 Terrace3 < 1.7744	21 Mbed2 < 1.7990	20 Boudoir < 1.8155	11 Sbed < 1.9141	10 Storage = 1.9305	30 Roofgrd1 < 1.9305	22 MBTerrace < 2.1276	31 Roofgrd2 < 2.2262	12 SBwc < 2.2427	32 Roofgrd23 < 2.5384	33 Roofgrd4 2.8670				
Reynaldo	9 Passage < 0.8775	2 Dining < 0.8887	10 Hkitchen < 0.9450	1 Living < 0.9900	19 Garage1 < 1.0462	12 Corridor1 < 1.0800	20 Garage2 < 1.1137	4 Hstairs < 1.1587	13 Corridor2 < 1.1812	18 Mbed < 1.1925	17 HMbed < 1.2150	11 Kitchen = 1.3050	3 Space < 1.3500	15 Bed2 < 1.3950	5 Stairs < 1.4512	14 Bed 1 = 1 5412	16 Bwc < 1.5412	6 Office1 = 1.7775	7 Office2 < 1.7775
	8 Veranda 2.1262																		
Borsoi	1 Living1 < 0.8730	9 Stairs < 0.9921	2 Dining < 1.0952	3 Living2 < 1.1032	10 Office < 1 1270	4 Corridor1 = 1.2064	24 Garage < 1.2064	6 Copa < 1.2381	12 Ramp < 1.2937	11 Library < 1.4524	13 Hall < 1.4762	5 Toilet < 1.5318	7 Kitchen = 1.5635	8 Stairs = 1.5635	43 *EXT* < *1.5635*	23 Laundry < 1.6032	16 Bed2 = 1.7222	17 Corridor2 < 1.7222	25 Sbedh = 1.746
	26 Sbwc = 1.746	27 Sbed2 < 1.746	14 Bwc = 1.8016	15 Bed1 < 1.8016	18 Toilet < 1.9683	19 Passage1 = 2.2619	20 Mbed < 2.2619	21 MBbwc = 2.5873	22 Closet 2.5873										
Esteves	3 Corridor1 < 0.9181	6 Stairs < 1.0185	4 Kitchen < 1.0472	2 Dining < 1.1333	7 Hall < 1.1476	5 Toilet < 1.3054	1 Living < 1.3341	17 Garage < 1.3771	11 Corridor2 < 1.3915	8 Veranda = 1.5349	9 ClothClst = 1.5349	10 Bed1 < 1.5349	13 Corridor3 = 1.6927	29 *EXT* < *1.7214*	12 Bed2 < 1.7788	14 Bwc = 2 0801	15 Bed3 = 2.0801	16 Bed4 = 2.0801	18 Sbed = 2.0801
	19 Sbwc 2.0801																		
Domingues	5 Copa < 0 8461	9 Passage2 < 0.8708	10 Garage < 0.8954	4 Dining < 0.9036	2 Living1 < 0.9776	6 Passage1 < 1.0022	7 Kitchem < 1.0515	11 Passage3 < 1.0761	1 Hall < 1.1419	14 Mbed < 1.1501	8 Kitchen2 < 1.1747	13 Closet < 1.1829	15 Bedh < 1.2322	18 Bed 2 < 1.2569	19 Office = 1.2733	20 Sbwc < 1.2733	42 EXT < 1.2815	3 Living2 < 1.3062	12 Bwc 1 < 1.4047
	16 Passage4 < 1 5197	21 Sbed < 1.7005	17 Bwc2 < 1 8483	30 Storage 1.8812															
Campello	4 Dining < 0.7537	5 Kitchen < 0.8437	6 Corridor1 = 0 8775	3 Living < 0.9000	1 Vestibule < 1.0462	2 Office < 1.0687	7 Passage1 < 1.1025	9 Corridor2 < 1.1250	19 Garage < 1.3387	15 Toilet < 1.3950	8 Cloth Clst = 1.4625	11 Lavatory < 1.4625	10 Mbed = 1.4850	13 Bedh = 1.4850	14 Bed2 < 1.4850	16 Sbed = 1.6762	17 Storage = 1.6762	18 Sbwc < 1.6762	12 Bwc < 1 8225
	34 *EXT* *1 845*																		
Svenson	5 Corridor1 < 0.4315	1 Liv/dining < 0 5274	7 Sbed < 0 6713	10 Mbed < 0.7432	11 Corridor2 < 0.7672	8 Living2 = 0.7911	9 Bed1 < 0.7911	2 Passage < 0.8391	6 Bwc < 0.8870	4 Laundry < 1.0788	3 Kitchen < 1.1747	12 MBbwc < 1.2227	21 *EXT* *1.4624*						
Pontual	22 Hall < 1.1417	21 Passage3 < 1.2183	17 Laundry < 1.2566	20 Stairs1 < 1.2821	1 Vestibule < 1.2948	2 Passage 1 < 1.3203	16 Passage 2 < 1.3331	13 Living < 1.3905	15 Kitchen < 1.3969	14 Dining < 1.4224	23 Space < 1.4479	24 Shower < 1.4734	3 Corridor < 1.5117	18 Sbath = 1.5627	19 Sbed < 1.5627	7 HMbed < 1.7541	4 Bed1 = 1.8179	5 Bwc = 1 8179	6 Bed2 < 1 8179
	25 Toilet < 2.0028	8 Office < 2.0092	26 Sbed2 < 2.0411	9 Mbed < 2.2771	11 MBBwc1 < 2.5705	10 Closet < 2.5833	12 MBBwc2 2.8767												

The service spaces are highlighted in bold

Table A.2.6. Recife architects' houses: rank order of visual integration (the whole complex)

House																						
Amorim	42 EXT 0.082 <	39 Southgrdn 0.090 <	38 Westgrdn 0.107 <	41 Northgrdn 0.115 <	40 Eastgrdn 0.123 <	13 stairs 0.123 <	9 kitchen 0.173 <	37 SouthVrnd 0.181 <	8 passage1 0.189 =	34 entrance 0.189 =	5 dining 0.189 <	4 vestibule 0.197 <	36 NorthVrnd 0.205 =	14 space 0.205 =	6 living1 0.205 <	1 hall 0.214 <	21 Mbed2 0.222 =	26 terrace2 0.222 <	11 Sbed 0.238 =	19 Mbed1 0.238 <	15 Hallst 0.246 <	25 terrace1 0.255 =
	28 stairs2 0.255 =	23 bed 0.255 <	31 Roofgrd2 0.271 =	35 EastVrnd 0.271 =	2 office 0.271 <	33 Roofgrd4 0.279 <	30 Roofgrd1 0.288 <	29 passage3 0.288 <	20 boudoir 0.296 <	32 Roofgrd3 0.304 =	22 MBterrace 0.304 <	17 bwc1 0.312 =	24 passage2 0.312 <	27 terrace3 0.320 =	3 office 0.320 =	7 living2 0.320 <	16 HMbed 0.337 <	18 bwc2 0.378 <	10 storage 0.386 <	12 Sbwc 0.394		
Reynaldo	34 EXT 0.068 <	23 EastGrd 0.124 <	9 passage 0.135 <	26 North Grd 0.158 <	33 ExtMed 0.169 <	31 SEntrace 0.191 <	25 Terrace 0.214 =	2 dining 0.214 <	5 stairs 0.225 =	24 Grd 0.225 =	4 Hstairs 0.225 =	29 Service 0.225 <	30 Quital 0.236 <	10 Hkitchen 0.248 =	28 Laundry 0.248 <	6 office1 0.259 =	1 living 0.259 <	7 office2 0.270 =	3 space 0.270 <	18 Mbed 0.281 =	19 garage1 0.281 <	13 corridor2 0.293 =
	20 garage 2 0.293 <	15 bed 2 0.304 <	14 bed 1 0.315 =	17 HMbed 0.315 <	12 corridor1 0.326 <	8 veranda 0.338 =	27 Oitão 0.338 <	21 SBed 0.349 <	32 Backyard 0.383 <	11 kitchen 0.394 <	16 bwc 0.529 <	22 SBwc 0.551										
Borsoi	43 EXT 0.151 <	1 living1 0.175 <	3 living2 0.183 al	28 Eastgrdm 0.183 <	30 Eastgrdn3 0.191 <	29 Eastgrdn2 0.198 =	42 stairs 0.198 =	24 garage 0.198 =	38 quintal 0.198 =	34 passage2 0.198 <	2 dining 0.206	9 stairs 0.206 <	41 ExtMed1 0.214 =	10 office 0.214 <	32 Southgrdm 0.222 =	33 Southgrdn2 0.222 =	31 terrace 0.222 =	36 oitao 0.222 <	25 Sbed1 0.238 <	27 5 0.246 =	17 corridor2 0.246	40 Hserv 0.262 <
	35 Mentrance 0.270 <	16 bed2 0.278 =	37 passage3 0.278 <	11 library 0.286 =	12 ramp 0.286 <	15 bed1 0.310 <	20 Mbed 0.318 <	6 copa 0.333 <	18 toilet 0.349 =	13 hall 0.349 =	39 corridor4 0.349 <	26 Sbwc 0.357 =	7 kitchen 0.357 =	4 corridor1 0.357 <	14 bwc1 0.373 <	23 laundry 0.405 <	5 toilet 0.444 <	8 storage 0.468 <	19 passage1 0.500 <	21 bwc2 0.508 <	22 closet 0.627	
Esteves	24 quintal 0.187 =	6 stairs 0.187 <	29 EXT 0.244 =	8 veranda 0.244 <	16 bed4 0.258 =	7 hall 0.258 <	12 bed2 0.273 =	9 ClothClst 0.273 <	3 corridor1 0.301 <	15 bed3 0.316 =	10 bed1 0.316 =	28 Sentrance 0.316 <	1 living 0.330 <	23 Eastgrdn 0.344 =	21 Westgrdn 0.344	22 Northgrdn 0.373 =	11 corridor2 0.373 <	13 corridor3 0.387 =	25 oitao 0.387 =	4 kitchen 0.387 <	27 passage 0.402 =	2 dining 0.402 <
	20 entrance 0.416 <	17 garage 0.445 =	5 toilet 0.445 <	18 Sbed 0.459 =	26 Hservice 0.459 <	19 Sbwc 0.531 <	14 bwc 0.560															
Domingues	2 living1 0.115 <	4 dining 0.140 <	24 veranda1 0.156 <	3 living2 0.164 <	1 hall 0.173 =	5 copa 0.173 <	35 quintal 0.197 =	25 veranda 0.197 <	26 stairs1 0.205 <	37 Westgrdn 0.214	38 terrace 0.214 <	15 bed 1 0.222 <	6 passage1 0.230 =	10 garage 0.230 =	9 passage2 0.230 <	42 EXT 0.238 =	11 passage3 0.238 <	14 Mbed 0.246 <	18 bed 2 0.263 <	7 kitchem 0.263 <	36 passage6 0.271 =	13 closet 0.271 <
	27 patio 0.288 <	19 office 0.296 =	34 Parking 0.296 <	40 stairs3 0.312 =	39 entrance2 0.312 <	28 piloti 1 0.329 <	41 entrance1 0.345 <	16 passage4 0.353 =	8 kitchen2 0.353 <	33 oitao 0.361 <	31 patio 2 0.370 <	23 passage5 0.378 =	22 laundry 0.378 <	29 piloti2 0.427 <	21 Sbed 0.435 <	12 bwc1 0.444 <	32 stairs2 0.477 <	20 Sbwc 0.501 <	17 bwc2 0.526 <	30 storage 0.608		
Campello	24 terrace 0.101 <	34 EXT 0.146 =	4 dining 0.146 <	32 access 0.158	9 corridor 2 0.169 =	2 office 0.169 =	6 corridor1 0.169 <	22 pateo1 0.180 =	23 pateo2 0.180 =	3 living 0.180 <	28 frontgrdn2 0.203 <	5 kitchen 0.225 <	31 laundry 0.248 =	27 frontgrdm 0.248 =	1 vestibule 0.248 =	29 Scorridor 0.248 <	30 quintal 0.259 <	20 backgrdm 0.281 =	26 Entrance 0.281 <	33 access 0.293 <	7 passage1 0.315 =	25 passage2 0.315 <
	10 Mbed 0.338 =	13 bed1 0.338 =	14 bed2 0.338 <	15 toilet 0.360 <	19 garage 0.371 <	8 closet 0.383 =	11 lavatory 0.383 <	21 backgrdn2 0.416 <	16 Sbed 0.461 <	12 bwc 0.518 <	17 storge 0.608 =	18 Sbwc 0.608										
Svenson	5 corridor 0.000 <	1 liv/dining 0.072 <	16 patio 0.120 <	18 Eatsgrdn 0.168 <	8 living2 0.192 <	14 Westgrdn 0.216 =	15 terrace 0.216 <	13 quintal 0.240 =	10 Mbed 0.240 <	17 oitao 0.264 =	2 passage 0.264 <	21 EXT 0.288 =	3 kitchen 0.288 =	20 oitao1 0.288 =	9 bed1 0.288 =	11 corridor1 0.288 <	4 laundry 0.312	19 Bedterrace 0.312 <	12 Mbwc 0.336 <	7 Sbed 0.384 <	6 bwc 0.408	
Pontual	50 EXT 0.070 <	34 EastGrd 0.128 <	47 quintal3 0.160 <	36 parking 0.166 =	41 service1 0.166 =	28 terrace1 0.166 <	33 SouthGrd 0.172 =	35 NorthGrd 0.172 <	44 quintal1 0.179 =	49 Extmed 0.179 <	37 Entrance 0.185 =	48 Sstairs 0.185 <	46 quintal2 0.211 =	14 dining 0.211 <	27 Pergola 0.217 <	38 passage4 0.223 <	45 service2 0.230 =	39 stairs 2 0.230 =	29 terrace2 0.230 <	30 terrace3 0.242 =	2 passage 1 0.242 <	1 vestibule 0.249 <
	3 corridor 0.249 <	43 passage6 0.255 =	13 living 0.255 =	20 stairs 0.255 <	40 passage5 0.262 =	22 hall 0.262 <	31 terrace4 0.268 <	4 bed1 0.281 =	15 kitchen 0.281 <	8 office 0.287 =	6 bed2 0.287 <	32 passage3 0.293 =	21 passage 3 0.293 <	9 Mbed 0.300 <	10 closet 0.306 =	7 HMbed 0.306 <	17 laundry 0.313 <	19 Sbed 0.319 =	23 space 0.319 <	42 passage5 0.325 <	11 MBbwc1 0.338 <	12 MBbwc2 0.344 <
	24 shower 0.357 <	5 bwc 0.427 <	16 passage2 0.434 <	25 toilet 0.453 <	26 Sbed 2 0.478 <	18 Sbwc 0.523																

Table A.2.7. Amorim house: syntactic data (inside)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	hall	t	b	s	2	1.377	9	0.377
2	ofiice reception	f	b	s	2	1.718	6	0.600
3	office	f	a	s	1	2.083	2	0.730
4	vestibule	t	b	s	4	1.059	8	0.388
5	dining	f	b	s	3	1.259	9	0.377
6	living 1	f	b	s	2	1.601	9	0.377
7	living 2	f	a	s	1	1.966	3	0.659
8	passage 1	t	b	m1	2	1.530	11	0.318
9	kitchen	f	b	se	3	1.824	12	0.330
10	storage	f	a	se	1	2.189	2	0.683
11	maid's bed	f	b	se	2	2.166	6	0.424
12	maid's bwc	f	a	se	1	2.531	2	0.683
13	stairs	t	b	m	2	0.977	19	0.165
14	space	f	a	s	1	1.424	9	0.353
15	hall 1st	t	c	p	5	0.918	14	0.235
16	hall main bed	t	c	p	3	1.165	10	0.365
17	bwc1	f	c	p	3	1.201	10	0.330
18	bwc2	f	a	p	1	1.565	6	0.436
19	main bed 1	f	b	p	3	1.459	10	0.341
20	boudoir	f	a	p	1	1.824	3	0.647
21	main bed 2	f	b	p	2	1.801	9	0.353
22	private terrace	f	a	p	1	2.166	2	0.694
23	bed	f	a	p	1	1.283	5	0.541
24	passage 2	t	c	p	4	1.071	10	0.330
25	terrace 1	f	c	p	2	1.412	8	0.365
26	terrace 2	f	c	p	3	1.401	9	0.353
27	terrace 3	f	a	p	1	1.765	8	0.341
28	stairs 2	t	b	p	2	1.318	11	0.306
29	passage 3	t	b	p	2	1.589	6	0.577
30	Roofgrd1	f	b	p	2	1.883	6	0.577
31	Roofgrd2	f	b	p	2	2.201	5	0.589
32	Roofgrd3	f	b	p	2	2.542	4	0.836
33	Roofgrd4	f	a	p	1	2.907	5	0.577
MEAN					2.06	1.672	7.52	0.462

Table A.2.8. Amorim house: syntactic data (the whole complex)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	hall	t	c	s	3	1.060	15	0.214
2	ofiice reception	f	b	s	2	1.372	13	0.271
3	office	f	a	s	1	1.701	9	0.320
4	vestibule	t	c	s	4	0.912	17	0.197
5	dining	f	c	s	3	1.060	18	0.189
6	living 1	f	c	s	3	1.224	16	0.205
7	living 2	f	a	s	1	1.553	7	0.320
8	passage 1	t	b	m1	2	1.323	18	0.189
9	kitchen	f	b	se	3	1.602	20	0.173
10	storage	f	a	se	1	1.931	4	0.386
11	maid's bed	f	b	se	2	1.914	12	0.238
12	maid's bwc	f	a	se	1	2.243	3	0.394
13	stairs	t	b	m	2	0.928	26	0.123
14	space	f	a	s	1	1.240	16	0.205
15	hall 1st	t	c	p	5	0.961	14	0.246
16	hall main bed	t	c	p	3	1.208	10	0.337
17	bwc1	f	c	p	3	1.232	10	0.312
18	bwc2	f	a	p	1	1.561	6	0.378
19	main bed 1	f	b	p	3	1.487	13	0.238
20	boudoir	f	a	p	1	1.816	6	0.296
21	main bed 2	f	b	p	2	1.799	14	0.222
22	private terrace	f	a	p	1	2.128	6	0.304
23	bed	f	a	p	1	1.290	10	0.255
24	passage 2	t	c	p	4	1.142	10	0.312
25	terrace 1	f	c	p	2	1.454	11	0.255
26	terrace 2	f	c	p	3	1.446	14	0.222
27	terrace 3	f	a	p	1	1.774	8	0.320
28	stairs 2	t	b	p	2	1.388	12	0.255
29	passage 3	t	b	p	2	1.651	9	0.288
30	Roofgrd1	f	b	p	2	1.931	9	0.288
31	Roofgrd2	f	b	p	2	2.226	10	0.271
32	Roofgrd3	f	b	p	2	2.538	9	0.304
33	Roofgrd4	f	a	p	1	2.867	8	0.279
34	entrance	t	d	s	5	1.224	18	0.189
35	East veranda	f	d	s	4	1.503	14	0.271
36	North veranda	t	d	se1	3	1.717	16	0.205
37	South veranda	f	d	s	4	1.372	19	0.181
38	West garden	f	d	se1	4	1.635	28	0.107
39	front garden	f	d	s	5	1.421	30	0.090
40	East garden	f	d	s	4	1.495	26	0.123
41	North garden	f	d	se1	4	1.709	27	0.115
42	street		a		1	1.750	31	0.082
MEAN					2.48	1.566	14.10	0.242

Table A.2.9. Reynaldo house: syntactic data (inside)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	living	f	b	s	2	1.507	6	0.572
2	dining	f	b	s	3	1.091	10	0.416
3	space	f	a	s	1	1.975	5	0.598
4	hall stairs	t	b	s	2	1.351	9	0.442
5	stairs	t	b	s	3	1.663	9	0.442
6	office1	f	c	s	3	2.053	7	0.494
7	office2	f	c	s	3	2.053	6	0.572
8	veranda	f	c	s	2	2.494	5	0.779
9	passage	t	b	m	3	0.987	11	0.260
10	hall kitchen	t	b	se	2	1.403	5	0.546
11	kitchen	f	a	se	1	1.871	2	0.702
12	corridor1	t	b	m	2	1.039	9	0.312
13	corridor2	t	c	p	5	1.143	7	0.338
14	bed 1	f	a	p	1	1.611	4	0.572
15	bed 2	f	c	p	2	1.507	5	0.494
16	bwc	f	a	p	1	1.611	5	0.650
17	hall Mbed	t	c	p	3	1.429	5	0.650
18	Main bed	f	b	p	2	1.793	6	0.624
19	garage1	t	b	se	2	2.208	2	1.065
20	garage 2	f	a	se	1	2.676	2	1.065
MEAN					2.20	1.673	6.00	0.579

Table A.2.10. Reynaldo house: syntactic data (the whole complex)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	living	f	c	s	3	0.990	12	0.259
2	dining	f	c	s	3	0.889	16	0.214
3	space	f	a	s	1	1.350	11	0.270
4	hall stairs	t	b	s	2	1.159	15	0.225
5	stairs	t	b	s	3	1.451	15	0.225
6	office1	f	c	s	3	1.778	12	0.259
7	office2	f	c	s	3	1.778	11	0.270
8	veranda	f	c	s	2	2.126	8	0.338
9	passage	t	d	m	3	0.878	21	0.135
10	hall kitchen	t	c	se	3	0.945	12	0.248
11	kitchen	f	a	se	1	1.305	5	0.394
12	corridor1	t	c	m	2	1.080	9	0.326
13	corridor2	t	d	p	5	1.181	10	0.293
14	bed 1	f	a	p	1	1.541	8	0.315
15	bed 2	f	c	p	2	1.395	9	0.304
16	bwc	f	a	p	1	1.541	5	0.529
17	hall Mbed	t	c	p	3	1.215	8	0.315
18	Main bed	f	c	p	2	1.193	10	0.281
19	garage1	t	d	se	3	1.046	9	0.281
20	garage 2	f	c	se	2	1.114	8	0.293
21	SBed	f	a	se	1	1.384	8	0.349
22	SBwc	f	a	se	1	1.384	4	0.551
23	EastGrd	f	d	s	5	1.046	22	0.124
24	garden	f	c	s	2	1.249	14	0.225
25	Terrace	f	d	s	4	0.990	15	0.214
26	North Grd	f	d	s	3	1.069	20	0.158
27	Oitão	t	c	se	2	1.069	6	0.338
28	Laundry	f	d	se	4	0.934	12	0.248
29	Service	t	d	se	5	1.024	14	0.225
30	Quintal	f	c	se	2	1.170	13	0.236
31	SEntrace	t	d	se	4	1.103	16	0.191
32	Backyard	f	a	se	1	1.463	4	0.383
33	ExtMediator	t	c	ext	2	1.384	19	0.169
34	Exterior	exterior	c	ext	2	1.440	27	0.068
MEAN					2.53	1.255	12.00	0.272

Table A.2.11. Borsoi house: syntactic data (inside)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	living 1	f	b	s	3	1.467	10	0.356
2	dining	f	b	s	2	1.689	7	0.422
3	living 2	f	a	s	1	1.911	11	0.267
4	corridor 1	t	b	m1	3	1.956	5	0.689
5	toilet	f	a	s1	1	2.400	3	0.756
6	copa	f	b	se	3	2.311	5	0.689
7	kitchen	f	a	se	1	2.756	5	0.689
8	storage	f	a	se	1	2.756	2	1.111
9	staircase	t	b	m	2	1.333	12	0.244
10	office	f	b	m	3	1.244	11	0.267
11	library	f	a	s	1	1.689	10	0.289
12	ramp	t	b	m	2	1.244	10	0.289
13	hall	t	c	p	5	1.289	9	0.422
14	bwc 1	f	a	p	1	1.733	7	0.467
15	bed1	f	a	p	1	1.733	7	0.467
16	bed2	f	c	p	2	1.511	10	0.378
17	corridor 2	t	c	p	2	1.511	12	0.333
18	toilet	f	d	p	4	1.733	8	0.422
19	passage	t	c	p	3	2.089	6	0.622
20	main bed	f	c	p	3	2.089	6	0.622
21	bwc 2	f	a	p	1	2.533	5	0.644
22	closet	f	a	p	1	2.533	3	1.022
MEAN					2.09	1.887	7.45	0.521

Table A.2.12. Borsoi house: syntactic data (the whole complex)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	living 1	f	d	s	5	0.873	23	0.175
2	dining	f	c	s	2	1.095	19	0.206
3	living 2	f	c	s	2	1.103	22	0.183
4	corridor 1	t	c	m1	3	1.206	10	0.357
5	toilet	f	a	s1	1	1.532	3	0.444
6	copa	f	c	se	4	1.238	13	0.333
7	kitchen	f	a	se	1	1.564	10	0.357
8	storage	f	a	se	1	1.564	7	0.468
9	staircase	t	b	m	2	0.992	19	0.206
10	office	f	b	m	3	1.127	16	0.214
11	library	f	a	s	1	1.452	12	0.286
12	ramp	t	b	m	2	1.294	12	0.286
13	hall	t	c	p	5	1.476	9	0.349
14	bwc 1	f	a	p	1	1.802	7	0.373
15	bed1	f	a	p	1	1.802	12	0.310
16	bed2	f	c	p	2	1.722	15	0.278
17	corridor 2	t	c	p	2	1.722	18	0.246
18	toilet	f	d	p	4	1.968	8	0.349
19	passage 1	t	c	p	3	2.262	6	0.500
20	main bed	f	c	p	3	2.262	11	0.318
21	bwc 2	f	a	p	1	2.587	5	0.508
22	closet	f	a	p	1	2.587	3	0.627
23	laundry	f	a	se	1	1.603	9	0.405
24	garage	f	d	se	3	1.206	20	0.198
25	maid's bed1	f	a	se	1	1.746	15	0.238
26	maid's bwc	f	a	se	1	1.746	12	0.357
27	maid's bed2	f	a	se	1	1.746	15	0.246
28	front garden 1	f	d	s	5	1.056	19	0.183
29	front garden 2	f	c	s	2	1.333	18	0.198
30	front garden 3	f	d	s	4	1.143	19	0.191
31	terrace	f	d	s	5	1.032	18	0.222
32	front garden 4	f	d	s	3	1.254	17	0.222
33	front garden 5	f	d	s	3	1.246	16	0.222
34	passage 2	t	d	s	4	1.135	18	0.198
35	main entrance	t	d	s	3	0.952	13	0.270
36	oitao	t	d	se	4	1.016	20	0.222
37	passage 3	t	d	se	4	1.127	15	0.278
38	quintal	f	d	se	4	1.143	20	0.198
39	corridor 4	t	d	se	4	1.278	11	0.349
40	servant's hall	t	b	se	4	1.421	14	0.262
41	ext mediator 1	t	c	se	2	1.468	17	0.214
42	ext mediator 2	t	c	s	2	1.333	17	0.198
43	exterior	e	c	e	2	1.564	23	0.151
MEAN					2.60	1.460	14.09	0.288

Table A.2.13. Esteves house: syntactic data (inside)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	living	f	a	s	1	2.049	4	0.493
2	dining	f	b	s	2	1.517	4	0.493
3	corridor1	t	b	m	4	1.062	5	0.455
4	kitchen	f	a	se	1	1.593	3	0.531
5	toilet	f	a	s1	1	1.593	5	0.455
6	staircase	t	b	m	2	0.835	13	0.076
7	hall	t	b	p	5	0.683	8	0.266
8	veranda	f	a	p	1	1.214	9	0.228
9	clothes closet	f	a	p	1	1.214	7	0.304
10	bed1	f	a	p	1	1.214	4	0.417
11	corridor2	t	b	p	3	0.835	10	0.190
12	bed2	f	a	p	1	1.366	7	0.304
13	corridor3	t	b	p	4	1.138	9	0.228
14	bwc	f	a	p	1	1.669	5	0.569
15	bed3	f	a	p	1	1.669	5	0.569
16	bed4	f	a	p	1	1.669	8	0.266
MEAN					1.88	1.333	6.63	0.365

Table A.2.14. Esteves house: syntactic data (the whole complex)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	living	f	d	s	3	1.334	9	0.330
2	dining	f	c	s	2	1.133	8	0.402
3	corridor1	t	c	m	4	0.918	8	0.301
4	kitchen	f	c	se	2	1.047	4	0.387
5	toilet	f	a	s1	1	1.305	6	0.445
6	staircase	t	b	m	2	1.019	15	0.187
7	hall	t	b	p	5	1.148	11	0.258
8	veranda	f	a	p	1	1.535	12	0.244
9	rouparia	f	a	p	1	1.535	10	0.273
10	bed1	f	a	p	1	1.535	6	0.316
11	corridor2	t	b	p	3	1.392	10	0.373
12	bed2	f	a	p	1	1.779	9	0.273
13	corridor3	t	b	p	4	1.693	9	0.387
14	bwc	f	a	p	1	2.080	5	0.560
15	bed3	f	a	p	1	2.080	7	0.316
16	bed4	f	a	p	1	2.080	10	0.258
17	garage	f	c	se	2	1.377	3	0.445
18	maid's bed	f	a	se	1	2.080	6	0.459
19	maid's toilet	f	a	se	1	2.080	4	0.531
20	entrance	t	d	s	3	1.492	6	0.416
21	front garden	f	d	s	3	1.592	9	0.344
22	lateral garden	f	d	s	4	1.478	8	0.373
23	back garden	f	a	s	1	1.865	11	0.344
24	quintal	f	d	se	3	1.176	15	0.187
25	oitao	t	c	se	3	1.363	7	0.387
26	hall service	t	b	se	3	1.693	6	0.459
27	passage	t	c	se	2	1.549	6	0.402
28	service entrance	f	d	se	3	1.506	10	0.316
29	exterior		c	ext	2	1.721	12	0.244
MEAN					2.21	1.537	8.34	0.352

Table A.2.15. Domingues house: syntactic data (inside)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	hall	t	b	s	1	2.377	7	0.340
2	living 1	f	b	s	3	1.896	9	0.283
3	living 2	f	a	s	1	2.377	7	0.340
4	dining	f	b	s	2	1.528	10	0.255
5	copa	f	b	m	4	1.217	12	0.198
6	passage 1	t	a	m	1	1.698	5	0.481
7	kitchen 1	f	b	se	2	1.641	8	0.311
8	kitchen 2	f	a	se	1	2.122	4	0.509
9	passage 2	t	b	m	3	1.132	14	0.113
10	garage	f	a	se	1	1.613	7	0.424
11	passage 3	t	b	p	3	1.160	13	0.142
12	bwc 1	f	a	p	1	1.641	4	0.424
13	closet	f	b	p	2	1.302	14	0.113
14	main bedroom	f	b	p	2	1.500	8	0.283
15	bed 1	f	b	p	2	1.754	8	0.283
16	passage 4	t	b	p	3	2.066	6	0.424
17	bwc 2	f	a	p	1	2.547	4	0.679
18	bed 2	f	b	p	2	2.490	6	0.424
19	office	f	a	p	1	2.971	6	0.424
MEAN					1.89	1.844	8.00	0.340

Table A.2.16. Domingues house: syntactic data (the whole complex)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	hall	t	c	s	2	1.142	22	0.173
2	living 1	f	d	s	4	0.978	27	0.115
3	living 2	f	a	s	1	1.306	23	0.164
4	dining	f	d	s	3	0.904	25	0.140
5	copa	f	d	m	4	0.846	21	0.173
6	passage 1	t	c	m	2	1.002	14	0.230
7	kitchen 1	f	c	se	2	1.052	14	0.263
8	kitchen 2	f	c	se	2	1.175	10	0.353
9	passage 2	t	d	m	3	0.871	15	0.230
10	garage	f	d	se	3	0.895	14	0.230
11	passage 3	t	c	p	3	1.076	14	0.238
12	bwc 1	f	a	p	1	1.405	4	0.444
13	closet	f	c	p	2	1.183	14	0.271
14	main bedroom	f	d	p	3	1.150	17	0.246
15	bed 1	f	d	p	3	1.232	19	0.222
16	passage 4	t	c	p	3	1.520	9	0.353
17	bwc 2	f	a	p	1	1.848	4	0.526
18	bed 2	f	d	p	3	1.257	16	0.263
19	office	f	c	p	2	1.273	15	0.296
20	maid's bwc	f	a	se	2	1.273	4	0.501
21	maid's bed	f	a	se	1	1.701	7	0.435
22	laundry	f	c	se	3	1.199	8	0.378
23	passage 5	t	b	se	3	1.372	8	0.378
24	alpendre	f	d	s	4	0.928	23	0.156
25	veranda	f	d	p	6	0.969	20	0.197
26	stairs 1	t	c	s	2	1.158	19	0.205
27	patio	f	c	s	2	1.388	11	0.288
28	piloti 1	f	c	s	2	1.520	9	0.329
29	piloti 2	f	c	s	3	1.553	7	0.427
30	storage	f	a	se	1	1.881	3	0.608
31	patio 2	f	c	se	2	1.512	8	0.370
32	stairs 2	t	c	se	2	1.356	5	0.477
33	oitao	t	c	se	2	1.125	6	0.361
34	car entrance	t	d	se	4	1.002	11	0.296
35	quintal	f	d	se	3	1.167	20	0.197
36	passage 6	t	c	se	2	1.273	11	0.271
37	front garden	f	d	s	3	1.273	18	0.214
38	terrace	f	c	s	2	1.240	18	0.214
39	entrance 2	t	c	s	2	1.553	12	0.312
40	stairs 3	t	c	s	2	1.618	12	0.312
41	entrance 1	t	c	s	2	1.512	10	0.345
42	exterior	e	c	e	2	1.282	15	0.238
MEAN					2.53	1.332	12.53	0.306

Table A.2.17. Campelo house: syntactic data (inside)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	vestibule	t	c	s	2	1.730	3	0.817
2	library/office	f	c	s	2	1.730	3	0.817
3	living	f	c	s	3	1.201	4	0.769
4	dining	f	b	s	3	0.817	6	0.336
5	kitchen	f	a	se	1	1.394	4	0.433
6	corridor 1	t	b	m	3	0.625	5	0.384
7	passage	t	b	m	3	0.817	3	0.625
8	closet/storage	f	a	*	1	1.394	3	0.625
9	corridor 2	t	b	p	6	0.625	10	0.144
10	main bed	f	a	p	1	1.201	1	0.721
11	lavatory	f	b	p	2	1.105	2	0.673
12	bathroom	f	a	p	1	1.682	2	0.673
13	bed 1	f	a	p	1	1.201	2	0.673
14	bed 2	f	a	p	1	1.201	2	0.673
MEAN					2.14	1.194	3.57	0.597

* - space is used to support social and private activities

Table A.2.18. Campelo house: syntactic data (the whole complex)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	vestibule	t	d	s	3	1.046	14	0.248
2	library/office	f	d	s	3	1.069	21	0.169
3	living	f	d	s	4	0.900	20	0.180
4	dining	f	d	s	4	0.754	20	0.146
5	kitchen	f	c	se	2	0.844	13	0.225
6	corridor 1	t	d	m	4	0.878	18	0.169
7	passage 1	t	c	m	3	1.103	8	0.315
8	closet/storage	f	a	*	1	1.463	4	0.383
9	corridor 2	t	b	p	5	1.125	18	0.169
10	main bed	f	a	p	1	1.485	6	0.338
11	lavatory	f	b	p	2	1.463	3	0.383
12	bathroom	f	a	p	1	1.823	2	0.518
13	bed 1	f	a	p	1	1.485	6	0.338
14	bed 2	f	a	p	1	1.485	6	0.338
15	toilet	f	a	s	1	1.395	5	0.360
16	maid's bed	f	a	se	1	1.676	3	0.461
17	storge	f	a	se	1	1.676	1	0.608
18	maid's bwc	f	a	se	1	1.676	1	0.608
19	garage	f	c	se	2	1.339	5	0.371
20	back garden 1	f	c	s	2	1.508	12	0.281
21	back garden 2	f	c	s	2	1.508	4	0.416
22	pateo 1	f	d	s	4	1.159	19	0.180
23	pateo 2	f	d	s	3	1.080	19	0.180
24	terrace	f	d	s	6	0.878	26	0.101
25	passage 2	t	c	s	3	1.035	9	0.315
26	portico	t	c	s	2	1.136	11	0.281
27	front garden 1	f	d	s	3	1.226	14	0.248
28	front garden 2	f	d	s	3	1.125	16	0.203
29	service corridor	t	d	se	3	0.934	11	0.248
30	quintal	f	c	se	2	1.148	10	0.259
31	laundry	f	c	se	5	1.316	12	0.248
32	access	t	d	em	4	1.485	19	0.158
33	social access	t	c	s	2	1.429	10	0.293
34	exterior	e	a	e	1	1.845	20	0.146
MEAN					2.53	1.279	11.35	0.291

Table A.2.19. Svenson house: syntactic data (inside)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	living/dining	f	b	s	2	0.638	9	0.128
2	passage	t	c	s	3	1.021	5	0.383
3	kitchen	f	c	se	2	1.596	5	0.383
4	laundry	f	c	se	2	1.596	4	0.447
5	corridor	t	c	m	7	0.383	11	0.000
6	wc	f	a	s1	1	1.021	2	0.574
7	maid's bed	f	a	se	1	1.021	2	0.574
8	private living	f	a	p	1	1.021	6	0.319
9	bed1	f	a	p	1	1.021	5	0.383
10	main bed	f	c	p	2	0.894	7	0.255
11	corridor1	t	c	p	3	0.830	5	0.383
12	wc1	f	a	p	1	1.468	5	0.383
MEAN					2.17	1.042	5.50	0.351

Table A.2.20. Svenson house: syntactic data (the whole complex)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	living/dining	f	d	s	4	0.527	17	0.072
2	passage	t	d	s	3	0.839	9	0.264
3	kitchen	f	c	se	2	1.175	8	0.288
4	laundry	f	d	se	3	1.079	7	0.312
5	corridor	t	d	m	8	0.432	20	0.000
6	wc	f	a	s1	1	0.887	3	0.408
7	maid's bed	f	c	se	2	0.671	4	0.384
8	private living	f	c	p	2	0.791	12	0.192
9	bed1	f	c	p	2	0.791	8	0.288
10	main bed	f	d	p	3	0.743	10	0.240
11	corridor1	t	c	p	3	0.767	8	0.288
12	wc1	f	a	p	1	1.223	6	0.336
13	quintal	f	d	se	3	0.839	10	0.240
14	front garden	f	c	m	3	1.007	11	0.216
15	porch/terrace	f	d	s	3	0.767	11	0.216
16	patio	f	d	s	4	0.551	15	0.120
17	oitao	t	c	p	2	0.863	9	0.264
18	back garden	f	d	p	3	1.031	13	0.168
19	private terrace	f	d	p	3	1.007	7	0.312
20	oitao1	t	c	p	2	1.103	8	0.288
21	exterior		a	ext	1	1.462	8	0.288
MEAN					2.76	0.884	9.71	0.247

Table A.2.21. Pontual house: syntactic data (inside)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	vestibule	t	b	s	2	1.344	9	0.414
2	passage 1	t	b	s	3	1.075	11	0.372
3	corridor	t	b	p	5	1.137	10	0.393
4	bed1	f	a	p	1	1.572	6	0.579
5	bathroom	f	a	p	1	1.572	5	0.579
6	bed2	f	a	p	1	1.572	5	0.579
7	hall main bed	t	b	p	2	1.365	7	0.517
8	office main be	f	b	p	2	1.634	6	0.579
9	main bed	f	b	p	3	1.944	5	0.807
10	closet	f	a	p	1	2.378	3	0.931
11	bath 1	f	b	p	2	2.337	3	1.199
12	bath 2	f	a	p	1	2.771	2	1.220
13	living	f	b	s	2	1.262	9	0.476
14	dining	f	b	s	2	1.489	9	0.393
15	kitchen	f	b	se	2	1.758	5	0.662
16	passage 2	t	b	se	2	2.068	4	1.034
17	laundry	f	b	se	3	2.420	4	1.034
18	maid's bath	f	a	se	1	2.854	3	1.055
19	maid's bed	f	a	se	1	2.854	3	1.055
20	stairs	t	b	s	2	1.654	8	0.434
21	passage 3	t	b	s	2	2.006	4	0.682
22	hall	t	b	s	2	2.399	6	0.579
23	space	f	a	s	1	2.833	1	1.013
MEAN					1.91	1.926	5.57	0.721

Table A.2.22. Pontual house: syntactic data (the whole complex)

Space number	label	function/ transition	space type	sector	space connectivity	RRA	visual connect	visual RRA
1	vestibule	t	d	s	3	1.295	14	0.249
2	passage 1	t	c	s	3	1.320	16	0.242
3	corridor	t	b	p	5	1.512	14	0.249
4	bed1	f	a	p	1	1.818	12	0.281
5	bathroom	f	a	p	1	1.818	5	0.427
6	bed2	f	a	p	1	1.818	11	0.287
7	hall main bed	t	b	p	2	1.754	9	0.306
8	office main bed	f	b	p	2	2.009	9	0.287
9	main bed	f	b	p	3	2.277	8	0.300
10	closet	f	a	p	1	2.583	6	0.306
11	bath 1	f	b	p	2	2.571	5	0.338
12	bath 2	f	a	p	1	2.877	4	0.344
13	living	f	c	s	2	1.391	14	0.255
14	dining	f	c	s	2	1.422	16	0.211
15	kitchen	f	c	se	2	1.397	8	0.281
16	passage 2	t	c	se	2	1.333	5	0.434
17	laundry	f	c	se	4	1.257	10	0.313
18	maid's bath	f	a	se	1	1.563	3	0.523
19	maid's bed	f	a	se	1	1.563	9	0.319
20	stairs	t	c	s	2	1.282	16	0.255
21	passage 3	t	c	s	2	1.218	10	0.293
22	hall	t	c	s	3	1.142	14	0.262
23	space	f	a	s	1	1.448	6	0.319
24	beach shower	f	a	s	1	1.473	7	0.357
25	toilet	f	a	s	1	2.003	4	0.453
26	maid's bed 2	f	a	se	1	2.041	2	0.478
27	internal garden	f	c	s	2	1.135	18	0.217
28	terrace1	f	d	s	5	1.065	24	0.166
29	terrace2	f	d	s	4	1.282	17	0.230
30	terrace3	f	d	s	4	1.416	15	0.242
31	terrace4	f	d	s	4	1.461	11	0.268
32	passage3	t	c	s	3	1.697	9	0.293
33	SouthGrd	f	d	s	4	1.531	23	0.172
34	EastGrd	f	d	s	4	1.486	30	0.128
35	NorthGrd	f	d	s	4	1.263	23	0.172
36	parking	t	d	s	3	1.276	24	0.166
37	SocialEntrance	t	c	s	2	1.429	22	0.185
38	passage4	t	c	s	2	1.493	16	0.223
39	social entrance	t	c	s	2	1.505	15	0.230
40	passage5	t	c	m	2	1.391	12	0.262
41	service1	f	d	se	7	1.167	24	0.166
42	passage5	t	c	se	2	1.448	10	0.325
43	passage6	t	d	se	3	1.429	12	0.255
44	quintal1	f	d	se	4	1.442	22	0.179
45	service2	f	b	se	2	1.735	15	0.230
46	quintal2	f	a	se	1	1.607	18	0.211
47	quintal3	f	d	se	4	1.301	24	0.160
48	Sstairs	t	d	se	4	1.193	21	0.185
49	Ext med	t	c	em	3	1.352	22	0.179
50	Ext	e	a	e	1	1.658	38	0.070
MEAN					2.52	1.559	14.04	0.266

Table A.3.1. Modern houses: general data

House			Designer		Location					Area		Convex	
Code	Owner	Year	Name	Profession	District	Neighbourhood	Social class	Storeys	Plot	House	Total	Interior
M1	Arthur dos Santos 1	1937	Mounier	architect	first	Boa Vista	middle-class	levels	203.00	167.00	26	16
M2	Arthur dos Santos 2	1937	Mounier	architect	first	Boa Vista	middle-class	levels	203.00	172.00	24	15
M3	Gilvan Carvalho	1947	Hélio Feijó	draftsman	third	Casa Forte	high middle-class	mezanine	760.00	315.00	34	16
M4	Milton Medeiros	1949	Mario Russo	architect	third	Casa Forte	high middle-class	levels	1134.00	365.00	45	33
M5	Aflitos	1949	Hélio Feijó	draftsman	first	Aflitos	high middle-class	levels	613.00	280.00	26	15
M6	Almir Azevedo	1953	Jayme	engineer	sixth	Boa Viagem	middle-class	levels	508.00	240.00	37	23
M7	Luciano Costa	1953	Acácio Gil Borsoi	architect	sixth	Boa Viagem	upper-class	levels	625.00	440.00	58	54
M8	Denise de Oliveira	1953	Artur Barreto	engineer	fourth	Caxangá	middle-class	ground	390.00	110.00	20	10
M9	Aloisio Freire	1954	Heitor Maia Neto	architect	sixth	Boa Viagem	upper-class	levels	370.00	450.00	40	21
M10	Vicente de Paula	1954	Oscar Niemeyer	architect	sixth	Boa Viagem	upper-class	levels	640.00	450.00	36	24
M11	Empresa	1954	Florismundo Lins	architect	first	Boa Viagem	high middle-class	levels	420.00	185.00	28	15
M12	Nestor Lins	1954	Augusto Reynaldo	architect	fourth	Madalena	high middle-class	ground	932.00	312.00	36	24
M13	Antonio Lages	1954	Delfim Amorim	architect	third	Casa Amarela	upper-class	levels	1250.00	790.00	57	49
M14	John Wechgelaar	1954	Mario Russo	architect	third	Casa Forte	high middle-class	levels	800.00	335.00	45	30
M15	Augusto Reynaldo	1954	Augusto Reynaldo	architect	fourth	Caxangá	middle-class	mezanine	450.00	198.00	32	22
M16	Alfredo Lages	1954	Delfim Amorim	architect	third	Casa Amarela	upper-class	levels	1250.00	530.00	35	29
M17	Paulo Merguihão	1954	Maurício Castro	architect	sixth	Boa Viagem	middle-class	ground	565.00	160.00	25	10
M18	José Almeida	1955	Acácio Gil Borsoi	architect	sixth	Boa Viagem	high middle-class	basement	480.00	205.00	35	15
M19	João Beltrão	1955	Reginaldo Esteves	architect	third	Capunga	middle-class	ground	380.00	160.00	25	11
M20	Salomão Kelner	1955	Reginaldo Esteves	architect	fourth	Madalena	high middle-class	basement	675.00	346.00	35	21
M21	Sergio Morel	1955	Heitor Maia Neto	architect	third	Rosarinho	middle-class	ground	457.00	190.00	31	15
M22	Acacio Gil Borsoi	1955	Acácio Gil Borsoi	architect	sixth	Boa Viagem	high middle-class	levels	435.00	291.00	40	27
M23	Brasiliense Cavalcanti	1955	Augusto Reynaldo	architect	third	Tamarineira	middle-class	levels	336.00	195.00	25	18
M24	Rildo Fonseca	1955	Waldecy Pinto	architect	first	•	middle-class	ground	392.00	162.00	24	11
M25	M. Cavadinha 1	1956	Waldecy Pinto/Renato Torres	architect	fourth	Madalena	high middle-class	levels	175.00	105.00	16	13
M26	Francisco Claudino	1956	Acácio Gil Borsoi	architect	third	Casa Forte	upper-class	levels	3300.00	390.00	48	31
M27	Ornilo Santiago	1956	Albuquerque	engineer	fourth	Prado	middle-class	ground	650.00	160.00	26	10
M28	M. Cavadinha 2	1956	Waldecy Pinto/Renato Torres	architect	fourth	Madalena	high middle-class	levels	635.00	325.00	35	19
M29	1528/5	1956	Aloysio Albuquerque	•	fifth	Afogados	middle-class	ground	450.00	190.00	20	10
M30	Pontes	1956	Joaquim Rodrigues	engineer	fourth	Torre	middle-class	levels	940.00	260.00	29	19
M31	Lopes Pereira	1956	Maurício Castro	architect	second	Rosarinho	middle-class	levels	420.00	223.00	29	21
M32	1816/4	1956	Severino Leão	architect	fourth	Madalena	middle-class	levels	420.00	170.00	29	18
M33	Castro e Silva	1956	José Norberto	engineer	first	Parnamirim	upper-class	levels	1900.00	650.00	57	31
M34	Euler Maia	1956	Herculano Bandeira	engineer	fourth	Cordeiro	middle-class	ground	442.00	180.00	20	10
M35	Jorge Oliveira	1957	Severino Leão	architect	fourth	Madalena	middle-class	levels	360.00	215.00	35	20
M36	3101/4	1957	Rafael Cavalcanti	engineer	fourth	Prado	middle-class	ground	360.00	133.00	18	8
M37	Hailton de Figueiredo	1957	Raimundo Nóbrega	engineer	fourth	Madalena	middle-class	levels	480.00	225.00	31	16
M38	Sales Asfora	1957	Ulysses Wanderley	•	fourth	Madalena	high middle-class	levels	416.00	189.00	34	20
M39	Campos	1957	Severino Leão	architect	fourth	Madalena	middle-class	levels	431.00	210.00	32	17
M40	Paulo de Biase	1957	José Nonato	engineer	fourth	Madalena	middle-class	ground	750.00	250.00	29	13
M41	1986/4	1957	Francisco Vasconcelos	•	fourth	Madalena	high middle-class	levels	480.00	290.00	37	21
M42	Lucia de Moraes	1957	Paulo Vaz	architect	fourth	•	middle-class	ground	515.00	160.00	20	11
M43	Waldemar Rodrigues	1957	Waldecy Pinto	architect	second	Rosarinho	middle-class	ground	580.00	261.00	34	14
M44	Alcoforado	1957	Marcos Domingues	architect	second	Casa Amarela	middle-class	ground	390.00	180.00	26	15
M45	Edmea Benbassat	1957	Augusto Reynaldo	architect	fourth	Torre	middle-class	levels	320.00	246.00	33	21
M46	Edmundo Cavalcanti	1957	Leonardo Vieira	engineer	fourth	Iputinga	middle-class	ground	480.00	115.00	16	6
M47	Humberto Ramos	1957	Manoel Caetano	engineer	fourth	•	high middle-class	levels	377.00	285.87	29	20
M48	José Chamixaes	1958	Paulo Vaz/Eduardo Burle	architect	third	Monteiro	high middle-class	ground	350.00	225.00	31	18
M49	Anneliese Poluzzi	1958	Acácio Gil Borsoi	architect	sixth	Boa Viagem	high middle-class	levels	331.00	346.00	43	23

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Table A.3.1. Modern houses: general data

House			Designer		Location				Area		Convex	
Code	Owner	Year	Name	Profession	District	Neighbourhood	Social class	Storeys	Plot	House	Total	Interior
M50	José Norberto	1958	José Norberto	engineer	sixth	Boa Viagem	high middle-class	levels	510.00	240.00	37	31
M51	Amaro Dias	1958	Delfim Amorim/Armindo Leal	architect	third	Casa Forte	high middle-class	levels	455.00	350.00	49	38
M52	Marilena Canto	1958	Waldecy Pinto	architect	third	Parnamirim	high middle-class	levels	2370.00	365.00	51	36
M53	Pinto Coelho	1958	Delfim Amorim/Armindo Leal	architect	third	Casa forte	upper-class	levels	973.00	328.00	45	27
M54	Antonio Carneiro	1958	Marcos Domingues/Carlos Falcão	architect	fourth	Madalena	high middle-class	levels	528.00	237.00	38	18
M55	Odacy Varejão	1958	Alberto Moura/Ilo Silva	architect	fourth	Madalena	middle-class	mezanine	450.00	185.00	30	15
M56	Hiberon Camargo	1958	Reginaldo Esteves	architect	first	Caxangá	middle-class	levels	490.00	228.00	28	16
M57	Alfredo Teixeira	1958	Jayme Fernandes	engineer	fourth	Madalena	high middle-class	levels	503.00	385.00	34	23
M58	Antonio Maaze	1958	Dilson Neves	architect	sixth	Boa Viagem	high middle-class	levels	491.00	387.00	38	22
M59	Waldecy Barreto	1958	Marcos Domingues/Carlos Falcão	architect	fourth	•	middle-class	ground	456.00	170.00	22	14
M60	Rafael Gomes	1958	Edison Lima	architect	sixth	Boa Viagem	middle-class	ground	660.00	215.00	28	14
M61	Pedro Lopes	1958	Delfim Amorim	architect	third	Casa Forte	middle-class	ground	754.00	173.00	25	12
M62	Edison Lima	1958	Edison Lima	architect	fourth	Cordeiro	middle-class	ground	450.00	133.00	21	9
M63	Romildo Pessoa	1958	Edison Lima	architect	third	Casa Forte	middle-class	ground	682.00	236.00	28	16
M64	Adelmar Xavier	1958	Augusto Reynaldo	architect	fourth	Madalena	high middle-class	basement	702.00	365.00	43	24
M65	Gilberto Soares	1959	Heitor Maia Neto	architect	sixth	Boa Viagem	upper-class	levels	517.00	224.00	39	29
M66	3236/4	1959	Alberto Moura/Ilo Silva	architect	fourth	Madalena	high middle-class	levels	450.00	240.00	32	19
M67	Lucila Falcão	1959	Edison Lima	architect	fourth	Prado	middle-class	ground	390.00	175.00	24	11
M68	Paulo Melo	1959	Paulo Vaz	architect	third	Campo Grande	middle-class	ground	600.00	134.00	20	11
M69	Reginaldo Esteves	1959	Reginaldo Esteves	architect	third	Casa Forte	high middle-class	levels	360.00	195.00	28	19
M70	Serafim Amorim	1960	Delfim Amorim	architect	fourth	Madalena	high middle-class	levels	450.00	232.00	36	20
M71	Hipólito Lopes	1960	Tertuliano Dionísio/Batista	architect	sixth	Boa Viagem	middle-class	ground	360.00	192.00	29	15
M72	José Cordeiro	1960	Heitor Maia Neto	architect	sixth	Boa Viagem	upper-class	levels	1504.00	705.00	60	41
M73	Leonor Andrade	1960	Geraldo Majella/Jardim	architect	third	Aflitos	high middle-class	levels	666.00	349.00	40	32
M74	2469/4	1960	Eduardo Monteiro	engineer	fourth	Engenho do Meio	middle-class	ground	450.00	110.00	16	7
M75	Cecílio Lins	1960	Wandenkolk Tinoco	architect	sixth	Boa Viagem	middle-class	ground	470.00	188.00	29	14
M76	Jayme Noya	1960	Joaquim Rodrigues	engineer	sixth	Boa Viagem	upper-class	levels	945.00	520.00	47	35
M77	Eliane Carvalho	1960	Hugo Marques	engineer	first	Derby	upper-class	levels	1711.00	540.00	57	36
M78	José Conte	1960	José Fernando Nunes de Carvalho	architect	sixth	Boa Viagem	upper-class	levels	1900.00	720.00	50	36
M79	José Albuquerque	1960	Jarbas Guimarães	architect	second	Rosarinho	high middle-class	levels	558.00	270.00	40	26
M80	Antonio Amorim	1960	Pinheiro/Alves Amorim	architect	third	Graças	upper-class	levels	720.00	502.00	63	47
M81	Hilson Macedo	1960	Walacy	engineer	fourth	Madalena	middle-class	ground	345.00	200.00	32	16
M82	Hélio B. Coutinho	1960	Edison Lima	architect	third	Graças	high middle-class	levels	406.00	220.00	31	18
M83	Joan Boggan	1961	Pedro Montenegro/Sá	architect	third	Parnamirim	high middle-class	levels	954.00	227.00	37	24
M84	Claudio	1961	Wandenkolk Tinoco	architect	first	Boa Vista	high middle-class	levels	455.00	319.00	44	26
M85	4496/4	1961	Rafael Cavalcanti	engineer	fourth	Madalena	high middle-class	levels	414.00	263.00	37	22
M86	Otávio Lobo	1961	Heitor Maia Neto	architect	sixth	Boa Viagem	high middle-class	levels	675.00	313.00	46	28
M87	Maria Tavares	1962	Caio Baltar	engineer	fourth	Madalena	high middle-class	levels	360.00	228.00	32	17
M88	Bráulio Pio	1962	Hélvio Polito	architect	fourth	Madalena	high middle-class	ground	444.00	200.00	27	19
M89	Maria Cavalcanti	1962	Armindo Leal	architect	fourth	Madalena	high middle-class	levels	700.00	270.00	44	33
M90	Alfredo Nader	1962	Edison Lima	architect	third	Graças	high middle-class	levels	800.00	365.00	41	28
M91	João Cavalcanti	1962	Vital Pessoa de Mello	architect	first	Derby	upper-class	levels	762.00	583.00	68	59
M92	Eraldo Carneiro	1962	Wandenkolk Tinoco	architect	third	Casa Amarela	middle-class	ground	372.00	182.00	21	12
M93	Mario Santoianni	1963	Heitor Maia Neto	architect	sixth	Boa Viagem	middle-class	ground	495.00	102.00	22	17
M94	Paulo Loureiro	1963	Flavio Marinho	architect	third	Monteiro	high middle-class	ground	1730.00	352.00	47	30
M95	Nivaldo Vasconcelos	1963	Waldecy Pinto/Pedro Didier/Renato Torres	architect	third	Parnamirim	high middle-class	ground	423.00	265.00	40	25
M96	Sérgio Cavalcanti	1963	Delfim Amorim	architect	sixth	Boa Viagem	high middle-class	ground	1300.00	230.00	38	25
M97	Hilda Kabaz	1963	João Castelo Branco	architect	sixth	Boa Viagem	high middle-class	basement	705.00	255.00	36	19
M98	Carlos Fernandes	1963	Delfim Amorim	architect	third	Casa forte	high middle-class	ground	864.00	380.00	33	15

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Table A.3.1. Modern houses: general data

House			Designer		Location				Area		Convex	
Code	Owner	Year	Name	Profession	District	Neighbourhood	Social class	Storeys	Plot	House	Total	Interior
M99	Arlindo Mahou	1963	Zenildo Caldas	architect	sixth	Boa Viagem	high middle-class	levels	1462.00	266.00	31	24
M100	Elias Fausto	1963	Delfim Amorim	architect	sixth	Pina	high middle-class	levels	708.00	154.00	27	18
M101	Carneiro Leão	1963	Marcos Domingues	architect	first	Aflitos	upper-class	levels	2640.00	562.00	48	33
M102	Marcos Domingues	1963	Marcos Domingues	architect	third	Casa Forte	high middle-class	basement	490.00	350.00	41	22
M103	José Telmo	1963	Marcos Domingues	architect	fourth	Casa Forte	middle-class	ground	493.00	180.00	24	14
M104	Renato Carneiro da Cunha	1963	Renato Carneiro da Cunha	architect	sixth	Boa Viagem	high middle-class	levels	500.00	270.00	35	22
M105	Maria Barbosa	1963	Silvino Oliveira	engineer	second	Rosarinho	middle-class	basement	360.00	255.00	38	20
M106	Luciano Costa-Camboim	1964	Delfim Amorim	architect	sixth	Setúbal	middle-class	ground	350.00	170.00	23	15
M107	Valle Junior	1964	Delfim Amorim	architect	third	Parnamirim	high middle-class	basement	658.00	244.00	37	19
M108	Luciano Costa-Navegantes	1964	Delfim Amorim/Heitor Maia Neto	architect	sixth	Boa Viagem	middle-class	levels	160.00	104.00	23	16
M109	Paulo Magalhães	1964	Delfim Amorim/Heitor Maia Neto	architect	sixth	Boa Viagem	middle-class	ground	565.00	150.00	28	15
M110	Wamil Pinto	1964	Waldecy Pinto/Pedro Didier/Renato Torres	architect	first	Graças	high middle-class	levels	780.00	300.00	34	18
M111	Manoel Souza	1964	Waldecy Pinto/Pedro Didier/Renato Torres	architect	sixth	Boa Viagem	middle-class	ground	784.00	253.00	31	20
M112	Clarindo de Albuquerque	1964	Vital Pessoa de Mello	architect	third	Casa Amarela	high middle-class	levels	565.00	365.00	40	21
M113	Maria Guimarães	1964	Delfim Amorim/Heitor Maia Neto	architect	third	Monteiro	high middle-class	levels	432.00	340.00	35	29
M114	Armindo Barata	1964	Alete Ramos	architect	second	Rosarinho	middle-class	basement	429.00	227.00	32	19
M115	Angelo Rizzo	1964	Acácio Gil Borsoi	architect	sixth	Boa Viagem	high middle-class	levels	246.00	310.00	32	26
M116	Paulo Darigo	1964	Zenildo Caldas	architect	sixth	Boa Viagem	middle-class	ground	496.00	150.00	24	10
M117	Pedro Machado	1964	Renato Carneiro da Cunha	architect	sixth	Boa Viagem	high middle-class	ground	962.00	300.00	30	16
M118	Gilberto Pacheco	1964	Zenildo Caldas	architect	Jaboatão	Piedade	middle-class	levels	600.00	225.00	34	20
M119	Eureles Cordeiro	1965	Zildo Caldas	architect	third	Casa Forte	high middle-class	levels	446.00	340.00	43	31
M120	Paulo Galvão	1965	Delfim Amorim/Heitor Maia Neto	architect	sixth	Boa Viagem	high middle-class	levels	420.00	320.00	37	24
M121	Caio Venicius	1965	Márcio Freitas	engineer	third	Casa Forte	middle-class	ground	364.00	162.00	22	12
M122	Ilvo Meirelles	1965	Geraldo Majella/Guimarães	architect	third	Parnamirim	high middle-class	levels	925.00	270.00	30	25
M123	Fernando Cunha	1965	Zenildo Caldas	architect	Jaboatão	Piedade	high middle-class	levels	630.00	320.00	46	28
M124	Carlos Eduardo	1965	Wandenkolk Tinoco	architect	sixth	Boa Viagem	middle-class	ground	480.00	258.00	38	17
M125	José Mendonça	1966	Juarez Benito	architect	second	Rosarinho	high middle-class	levels	430.00	350.00	35	21
M126	Leão Masur	1966	Delfim Amorim/Heitor Maia Neto	architect	fourth	Madalena	upper-class	ground	1182.00	326.00	44	28
M127	Jayme Torban	1966	Acácio Gil Borsoi	architect	sixth	Boa Viagem	upper-class	levels	480.00	420.00	39	27
M128	José Berinson	1966	Acácio Gil Borsoi	architect	sixth	Boa Viagem	upper-class	levels	1000.00	400.00	46	25
M129	José Brasileiro	1967	Waldecy Pinto/Pedro Didier/Renato Torres	architect	sixth	Boa Viagem	upper-class	levels	560.00	372.00	53	42
M130	Tarcisia Souza	1967	Waldecy Pinto/Pedro Didier/Renato Torres	architect	fourth	Rosarinho	high middle-class	levels	392.00	221.00	44	28
M131	João Batista	1967	Waldecy Pinto/Pedro Didier/Renato Torres	architect	sixth	Pina	high middle-class	levels	640.00	351.00	49	33
M132	Fernanda Costa	1967	Acácio Gil Borsoi	architect	sixth	Boa Viagem	upper-class	levels	1015.00	260.00	51	40
M133	Glauco Campello 1	1967	Glauco Campello	architect	sixth	Boa Viagem	middle-class	ground	624.00	200.00	33	19
M134	Carlos Lemos	1967	Vital Pessoa de Mello	architect	sixth	Boa Viagem	high middle-class	ground	915.00	240.00	31	20
M135	João Antonio	1967	Armindo Leal/Oliveira	architect	sixth	Boa Viagem	middle-class	ground	585.00	250.00	22	11
M136	José Melo	1967	Florismundo Lins	architect	fourth	Madalena	high middle-class	levels	420.00	298.00	36	27
M137	José Barros	1967	Carlos Falcão	architect	third	Casa Amarela	middle-class	levels	290.00	205.00	31	15
M138	Hylson Mota	1967	Reginaldo Esteves	architect	sixth	Boa Viagem	upper-class	levels	2600.00	700.00	65	45
M139	Fernando Teixeira	1968	Glauco Campello/Armando Holanda	architect	sixth	Boa Viagem	middle-class	ground	500.00	187.00	20	12
M140	Ednaldo Veloso	1968	Glauco Campello/Armando Holanda	architect	sixth	Boa Viagem	middle-class	ground	500.00	186.00	20	14
M141	José Gladis	1968	Glauco Campello	architect	sixth	Boa Viagem	high middle-class	ground	432.00	192.00	24	17
M142	Waldimir Miranda	1968	Glauco Campello/Armando Holanda	architect	sixth	Boa Viagem	middle-class	ground	513.00	190.00	24	17
M143	Haylton Seara	1968	Glauco Campello	architect	sixth	Boa Viagem	high middle-class	levels	390.00	314.00	39	31
M144	Erickson Pereira	1968	Glauco Campello/Armando Holanda	architect	sixth	Boa Viagem	middle-class	ground	500.00	187.00	21	9
M145	Amilcar Melo	1968	Vital Pessoa de Mello	architect	fourth	Madalena	high middle-class	levels	365.00	220.00	38	23
M146	Eloy Soriano	1968	Glauco Campello/Armando Holanda	architect	sixth	Boa Viagem	middle-class	ground	500.00	175.00	22	9
M147	Luiz Petribu	1968	Acácio Gil Borsoi	architect	fourth	Madalena	upper-class	levels	505.00	285.00	39	21

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Table A.3.1. Modern houses: general data

House			Designer		Location					Area		Convex	
Code	Owner	Year	Name	Profession	District	Neighbourhood	Social class	Storeys	Plot	House	Total	Interior
M148	Clemente Ribeiro	1968	Glauco Campello/Armando Holanda	architect	sixth	Boa Viagem	middle-class	ground	500.00	204.00	19	14
M149	Edmundo Machado	1968	Hugo Marques	engineer	fourth	Madalena	high middle-class	levels	367.00	298.00	35	23
M150	Geraldo Aguiar 1	1968	Glauco Campello	architect	sixth	Boa Viagem	high middle-class	levels	390.00	310.00	37	31
M151	Luiz Numeriano	1968	Zildo Caldas	architect	third	Casa Forte	upper-class	levels	2420.00	494.00	66	35
M152	Wilson Fontenelles	1968	Armindo Leal/Azevedo	architect	sixth	Boa Viagem	middle-class	ground	510.00	210.00	31	22
M153	7359/1-6	1968	Armando Holanda	architect	sixth	Boa Viagem	middle-class	ground	420.00	140.00	23	16
M154	Frank Svenson	1968	Frank Svenson	architect	Olinda	Bairro Novo	middle-class	ground	360.00	128.00	20	12
M155	Enário Castro	1968	Marcos Domingues/Frank Svenson	architect	third	Casa Forte	high middle-class	levels	420.00	300.00	30	20
M156	Paulo Meirelles	1968	Marcos Domingues	architect	third	Casa Forte	high middle-class	mezanine	902.00	350.00	47	28
M157	Salviano Machado	1969	Delfim Amorim/Heitor Maia Neto	architect	first	Derby	upper-class	levels	450.00	535.00	62	30
M158	Casimiro Pires	1969	Angela Aquino	architect	fourth	Madalena	middle-class	levels	350.00	165.00	36	17
M159	Dilhermano Melo	1969	Delfim Amorim/Heitor Maia Neto	architect	sixth	Boa Viagem	high middle-class	levels	450.00	197.00	32	19
M160	Rosa Borges	1969	Glauco Campello	architect	sixth	Boa Viagem	high middle-class	levels	332.00	270.00	48	35
M161	GeraldoGomes/Nehilde Trajano	1969	GeraldoGomes/Nehilde Trajano	architect	sixth	Boa Viagem	high middle-class	levels	627.00	386.00	49	31
M162	Esdras Marques	1969	Marcílio Neves	architect	second	Torreão	high middle-class	levels	544.00	430.00	61	32
M163	Zenaldo Rocha	1969	Marcos Domingues/Frank Svenson	architect	Jaboatão	Piedade	high middle-class	basement	840.00	280.00	39	14
M164	Joaquim Lopes	1969	Delfim Amorim/Heitor Maia Neto	architect	sixth	Boa Viagem	high middle-class	levels	411.00	290.00	42	29
M165	Hélio	1969	Alex Lomachinsky/Emanuel Lins	architect	third	Aflitos	high middle-class	levels	460.00	342.00	54	33
M166	Alfredo Correia Pereira	1969	Delfim Amorim/Heitor Maia Neto	architect	first	Madalena	middle-class	mezanine	420.00	242.00	37	21
M167	Glauco Campello 2	1970	Glauco Campello	architect	sixth	Boa Viagem	high middle-class	levels	468.00	196.00	29	15
M168	Sócrates Carvalho	1970	Oscar Uchoa	architect	sixth	Boa Viagem	middle-class	ground	620.00	212.00	32	19
M169	Luiz Villar	1970	Delfim Amorim/Heitor Maia Neto	architect	third	Dois Irmãos	upper-class	levels	1000.00	300.00	39	21
M170	Fernando Travassos	1970	Marcos Domingues	architect	third	Casa Forte	high middle-class	ground	500.00	227.00	27	20
M171	Reimar Ellrich	1970	Acácio Gil Borsoi	architect	sixth	Boa Viagem	high middle-class	levels	670.00	303.00	38	22
M172	Edne Cavalcanti	1970	Moisés Andrade/Mônica Raposo	architect	sixth	Boa Viagem	middle-class	levels	370.00	220.00	27	21
M173	João Santos	1970	Acácio Gil Borsoi	architect	sixth	Setúbal	upper-class	levels	1600.00	654.00	61	48
M174	Carlos Chermont	1970	Reginaldo Esteves	architect	sixth	Setúbal	upper-class	levels	540.00	578.00	68	60
M175	Murilo Martins	1970	Vital Pessoa de Mello	architect	first	Graças	high middle-class	levels	730.00	375.00	51	27
M176	Rubens Scavuzzi	1970	Vital Pessoa de Mello	architect	sixth	Boa Viagem	upper-class	levels	1000.00	410.00	53	33
M177	José Rodrigues	1970	Delfim Amorim/Heitor Maia Neto	architect	third	Casa Forte	upper-class	levels	3900.00	615.00	62	41
M178	Maria Tamires	1970	Delfim Amorim/Heitor Maia Neto	architect	sixth	Setúbal	middle-class	levels	426.00	156.00	23	14
M179	Luiz Lacerda Nilo	1970	Luiz Lacerda Nilo	architect	third	Apipucos	high middle-class	basement	386.00	215.00	30	12
M180	José Cunha	1970	Domingues, Marcos	architect	Jaboatão	Piedade	upper-class	levels	850.00	317.00	46	19
M181	Miguel Doherty	1970	Delfim Amorim/Heitor Maia Neto	architect	third	Monteiro	high middle-class	levels	653.00	395.00	43	29
M182	José Oliveira	1971	Zenildo Caldas	architect	sixth	Boa Viagem	high middle-class	levels	450.00	250.00	42	25
M183	Clênio Torres	1971	Acácio Gil Borsoi	architect	third	Monteiro	high middle-class	levels	402.00	314.00	50	33
M184	Nubio Gadelha	1971	Glauco Campello	architect	sixth	Boa Viagem	upper-class	levels	480.00	433.00	55	35
M185	João Coelho	1971	J&P/Hélvio Polito/Roberto Holanda	architect	sixth	Boa Viagem	middle-class	ground	705.00	285.00	39	28
M186	Antonio J. Marinho	1971	Glauco Campello	architect	sixth	Boa Viagem	upper-class	ground	968.00	347.00	40	29
M187	Emir Glassner	1972	Vital Pessoa de Mello	architect	first	Graças	upper-class	levels	1320.00	680.00	77	39
M188	José Jatobá	1972	Marcílio Neves/Fernando Neves	architect	sixth	Boa Viagem	high middle-class	levels	434.00	293.00	46	32
M189	Arthur Guerra	1972	Arthur Guerra	architect	fourth	Madalena	high middle-class	levels	375.00	243.00	41	32
M190	Paulo de Melo-D1	1973	WandenkolkTinoco/Enio Eskinazi	architect	first	Ilha do Leite	middle-class	mezanine	582.40	240.00	33	17
M191	João Pessoa de Souza	1973	Neves,Risale/Tavares,Dimitri	architect	sixth	Boa Viagem	high middle-class	levels	480.00	232.00	40	31
M192	Oswaldo Lobo	1973	Ivaldevan Calheiros	architect	first	Graças	middle-class	ground	558.00	209.00	33	24
M193	Marupirajó Oliveira	1973	Cristina Jucá	architect	sixth	Boa Viagem	high middle-class	basement	420.00	211.00	27	15
M194	Paulo de Melo D4	1973	WandenkolkTinoco/Enio Eskinazi	architect	first	Ilha do Leite	middle-class	ground	455.00	180.00	36	18
M195	Paulo de Melo D6	1973	WandenkolkTinoco/Enio Eskinazi	architect	first	Ilha do Leite	middle-class	mezanine	455.00	194.00	37	18
M196	Paulo de Melo D2	1973	WandenkolkTinoco/Enio Eskinazi	architect	first	Ilha do Leite	middle-class	ground	390.00	170.00	29	16

Table A.3.1. Modern houses: general data

House			Designer		Location					Area		Convex	
Code	Owner	Year	Name	Profession	District	Neighbourhood	Social class	Storeys		Plot	House	Total	Interior
M197	Francisco Pedrosa	1975	Helvio Polito/Zamir Caldas	architect	first	Tamarineira	upper-class	levels		870.00	410.00	52	41
M198	Ernesto Melo	1975	Reginaldo Esteves	architect	sixth	Boa Viagem	high middle-class	levels		390.00	450.00	57	36
M199	Marcelo Silveira	1975	Bernardo Dimenstein/Ferreira	architect	fourth	Madalena	high middle-class	levels		562.00	307.00	31	19
M200	Carlos Fernando Pontual	1975	J&P	architect	Jaboatão	Piedade	upper-class	levels		900.00	417.00	48	26
M201	Fernando Maranhão	1976	Armando Holanda	architect	fourth	Madalena	high middle-class	basement		700.00	290.00	36	13
M202	Sônia Mesquita	1977	J&P	architect	Olinda	Pau Amarelo	upper-class	ground		900.00	369.00	48	27
M203	Jorge Wicks	1978	Vital Pessoa de Mello	architect	sixth	Boa Viagem	high middle-class	levels		375.00	262.00	37	22
M204	Gilberto Trindade	1980	J&P	architect	fourth	Apipucos	upper-class	ground		675.00	230.00	42	27

Table A.3.2. Modern houses: the sectors' data

	House	Sectors'			House	Social			Social 1			Service			Service 1			Private			Int. Mediator			Int Mediator1			Ext. Mediator			Exterior		
number	owner	type	genotype	size	MRRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA
M1	Arthur dos Santos 1	T14	g2	6	1.337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
M2	Arthur dos Santos 2	T14	g2	6	1.337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
M3	Gilvan Carvalho	T2	g1	4	0.500	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M4	Milton Medeiros	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M5	Aflitos	T14	g2	6	1.337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
M6	Almir Azevedo	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M7	Luciano Costa	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M8	Denise de Oliveira	T15	g1	6	1.241	c	2	0.859				c	2	0.859				a	4	2.005	c	3	0.859				c	1	0.859	a	0	2.005
M9	Aloisio Freire	T18	g2	6	0.764	d	1	0.286				d	1	0.573				c	3	1.146	c	2	0.859	d	2	0.573				c	0	1.146
M10	Vicente de Paula	T14	g2	6	1.337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
M11	Empresa	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M12	Nestor Lins	T9	g2	5	0.568	d	1	0.000				d	1	0.473				c	2	0.946	d	2	0.473							c	0	0.946
M13	Antonio Lages	T3	g2	4	0.999	c	1	0.000				c	1	0.999				a	2	1.999										c	0	0.999
M14	John Wechgelaar	T14	g2	6	1.337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
M15	Augusto Reynaldo	T10	g3	5	0.568	d	1	0.473				d	1	0.000				c	2	0.946	d	2	0.473							c	0	0.946
M16	Alfredo Lages	T17	g1	6	0.859	d	1	0.573				d	1	0.573				c	3	1.146	c	2	0.859	c	2	0.859				c	0	1.146
M17	Paulo Merguilhão	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M18	José Almeida	T16	g1	6	1.146	d	2	0.573				d	2	0.573				a	4	2.005	c	3	0.859				c	1	0.859	a	0	2.005
M19	João Beltrão	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M20	Salomão Kelner	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M21	Sergio Morel	T9	g2	5	0.568	d	1	0.000				d	1	0.473				c	2	0.946	d	2	0.473							c	0	0.946
M22	Acacio G. Borsoi	T30	g2	7	1.121	d	1	0.392	a	3	1.766	d	1	0.785				a	3	1.962	b	2	0.981	c	2	0.785				c	0	1.177
M23	Brasiliense Cavalcanti	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M24	Rildo Fonseca	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M25	M Cavadinha 1	T16	g1	6	1.146	d	2	0.573				d	2	0.573				a	4	2.005	c	3	0.859				c	1	0.859	a	0	2.005
M26	Francisco Claudino	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M27	Ornilo Santiago	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M28	M Cavadinha 2	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M29	1528/5	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M30	Pontes	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M31	Lopes Pereira	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M32	1816/4	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M33	Castro e Silva	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M34	Euler Maia	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M35	Jorge Oliveira	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M36	3101/4	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M37	Hailton de Figueiredo	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M38	Sales Asfora	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M39	Campos	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M40	Paulo de Biase	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M41	1986/4	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M42	Lucia de Moraes	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M43	Waldemar Rodrigues	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M44	Alcoforado	T3	g2	4	0.999	c	1	0.000				c	1	0.999				a	2	1.999										c	0	0.999
M45	Edmea Benbassat	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M46	Edmundo Cavalcanti	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M47	Humberto Ramos	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M48	José Chamixaes	T31	g2	7	0.953	d	1	0.588	a	3	1.373	c	2	0.785				a	3	1.373	c	2	0.392				d	1	0.981	c	0	1.177
M49	Anneliese Poluzzi	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420

Table A.3.2. Modern houses: the sectors' data

House		Sectors'			House	Social			Social 1			Service			Service 1			Private			Int. Mediator			Int. Mediator1			Ext. Mediator			Exterior		
number	owner	type	genotype	size	MRRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA
M50	José Norberto	T17	g1	6	0.859	d	1	0.573				d	1	0.573				c	3	1.146	c	2	0.859	c	2	0.859				c	0	1.146
M51	Amaro Dias	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M52	Marilena Canto	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M53	Pinto Coelho	T17	g1	6	0.859	d	1	0.573				d	1	0.573				c	3	1.146	c	2	0.859	c	2	0.859				c	0	1.146
M54	Antonio Carneiro	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M55	Odacy Varejão	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M56	Hiberon Camargo	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M57	Alfredo Teixeira	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M58	Antonio Maaze	T19	g1	6	0.955	d	1	0.573	a	3	1.432	d	1	0.573				a	3	1.432	c	2	0.286							c	0	1.432
M59	Waldecy Barreto	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M60	Rafael Gomes	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M61	Pedro Lopes	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M62	Edison Lima	T11	g1	5	0.757	d	1	0.473				d	1	0.473				c	2	0.946	c	2	0.946							c	0	0.946
M63	Romildo Pessoa	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M64	Adelmar Xavier	T13	g2	5	1.136	c	2	0.473				c	2	0.946				a	3	1.893							c	1	0.473	a	0	1.893
M65	Gilberto Soares	T33	g2	7	0.729	d	1	0.392				d	2	0.588				c	3	0.981	c	2	0.785	c	2	0.785	d	1	0.588	c	0	0.981
M66	3236/4	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M67	Lucila Falcão	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M68	Paulo Melo	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M69	Reginaldo Esteves	T21	g1	6	1.050	c	1	0.859	a	3	1.432	c	1	0.859				a	3	1.432	c	2	0.286							c	0	1.432
M70	Serafim Amorim	T14	g2	6	1.337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
M71	Hipólito Lopes	T11	g1	5	0.757	d	1	0.473				d	1	0.473				c	2	0.946	c	2	0.946							c	0	0.946
M72	J. Cordeiro	T17	g1	6	0.859	d	1	0.573				d	1	0.573				c	3	1.146	c	2	0.859	c	2	0.859				c	0	1.146
M73	Leonor Andrade	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M74	2469/4	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M75	Cecílio Lins	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M76	Jayme Noya	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M77	Eliane Carvalho	T17	g1	6	0.859	d	1	0.573				d	1	0.573				c	3	1.146	c	2	0.859	c	2	0.859				c	0	1.146
M78	José Conte	T17	g1	6	0.859	d	1	0.573				d	1	0.573				c	3	1.146	c	2	0.859	c	2	0.859				c	0	1.146
M79	José Albuquerque	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M80	Antonio Amorim	T17	g1	6	0.859	d	1	0.573				d	1	0.573				c	3	1.146	c	2	0.859	c	2	0.859				c	0	1.146
M81	Hilson Macedo	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M82	Hélio B. Coutinho	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M83	Joan Boggan	T19	g1	6	0.955	d	1	0.573	a	3	1.432	d	1	0.573				a	3	1.432	c	2	0.286							c	0	1.432
M84	Claudio	T28	g4	7	0.953	d	1	0.785	a	3	1.570	d	1	0.588				c	3	0.981	c	2	0.981	c	2	0.588				c	0	1.177
M85	4496/4	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M86	Otávio Lobo	T18	g2	6	0.764	d	1	0.286				d	1	0.573				c	3	1.146	c	2	0.859	d	2	0.573				c	0	1.146
M87	Maria Tavares	T6	g1	5	1.136	c	1	0.946				c	1	0.946				a	3	1.893	c	2	0.473							c	0	1.420
M88	Bráulio Pio	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M89	Maria Cavalcanti	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M90	Alfredo Nader	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M91	João Cavalcanti	T17	g1	6	0.859	d	1	0.573				d	1	0.573				c	3	1.146	c	2	0.859	c	2	0.859				c	0	1.146
M92	Eraldo Carneiro	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M93	Mario Santoianni	T10	g3	5	0.568	d	1	0.473				d	1	0.000				c	2	0.946	d	2	0.473							c	0	0.946
M94	Paulo Loureiro	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M95	Nivaldo Vasconcelos	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M96	Sérgio Cavalcanti	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M97	Hilda Kabaz	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M98	Carlos Fernandes	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420

Table A.3.2. Modern houses: the sectors' data

House		Sectors'			House	Social			Social 1			Service			Service 1			Private			Int. Mediator			Int. Mediator1			Ext. Mediator			Exterior		
number	owner	type	genotype	size	MRRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA
M99	Arlindo Mahou	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M100	Elias Fausto	T16	g1	6	1.146	d	2	0.573				d	2	0.573				a	4	2.005	c	3	0.859				c	1	0.859	a	0	2.005
M101	Carneiro Leão	T14	g2	6	1.337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
M102	Marcos Domingues	T9	g2	5	0.568	d	1	0.000				d	1	0.473				c	2	0.946	d	2	0.473							c	0	0.946
M103	José Telmo	T17	g1	6	0.859	d	1	0.573				d	1	0.573				c	3	1.146	c	2	0.859	c	2	0.859				c	0	1.146
M104	Renato C. da Cunha	T6	g1	5	1.136	c	1	0.946				c	1	0.946				a	3	1.893	c	2	0.473							c	0	1.420
M105	Maria Barbosa	T10	g3	5	0 568	d	1	0.473				d	1	0.000				c	2	0.946	d	2	0.473							c	0	0.946
M106	Luciano Costa-Camboim	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M107	Valle Junior	T9	g2	5	0 568	d	1	0.000				d	1	0.473				c	2	0.946	d	2	0.473							c	0	0.946
M108	Luciano Costa Navegantes	T14	g2	6	1.337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
M109	Paulo Magalhães	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M110	Wamil Pinto	T30	g2	7	1.121	d	1	0.392	a	3	1.766	d	1	0.785				a	3	1.962	b	2	0.981	c	2	0.785				c	0	1.177
M111	Manoel Souza	T19	g1	6	0.955	d	1	0.573	a	3	1.432	d	1	0.573				a	3	1.432	c	2	0.286							c	0	1.432
M112	Clarindo de Albuquerque	T19	g1	6	0 955	d	1	0.573	a	3	1.432	d	1	0.573				a	3	1.432	c	2	0.286							c	0	1 432
M113	Maria Guimarães	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M114	Armindo Barata	T19	g1	6	0.955	d	1	0.573	a	3	1.432	d	1	0.573				a	3	1.432	c	2	0.286							c	0	1.432
M115	Angelo Rizzo	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M116	Paulo Darigo	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M117	Pedro Machado	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M118	Gilberto Pacheco	T5	g1	5	0 946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M119	Eureles Cordeiro	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M120	Paulo Galvão	T7	g2	5	1 325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1 420
M121	Caio Venicius	T7	g2	5	1 325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M122	Ilvo Meirelles	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M123	Fernando Cunha	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M124	Carlos Eduardo	T16	g1	6	1 146	d	2	0.573				d	2	0.573				a	4	2.005	c	3	0.859				c	1	0.859	a	0	2.005
M125	José Mendonça	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M126	Leão Masur	T5	g1	5	0 946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1 420
M127	Jayme Torban	T14	g2	6	1 337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
M128	José Berinson	T16	g1	6	1 146	d	2	0.573				d	2	0.573				a	4	2.005	c	3	0 859				c	1	0 859	a	0	2.005
M129	José Brasileiro	T5	g1	5	0 946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M130	Tarcisia Souza	T7	g2	5	1 325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M131	João Batista	T20	g2	6	0 764	d	1	0.286	c	2	0 859	d	1	0.573				a	3	1.432	d	2	0.286							c	0	1.146
M132	Fernanda Costa	T23	g2	7	1.009	d	1	0.392	c	2	1 373	d	1	0.588				a	3	1.962	d	2	0.785	b	2	0.981				c	0	0 981
M133	Glauco Campello 1 (NOW e15)	T14	g2	6	1 337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
M134	Carlos Lemos	T5	g1	5	0 946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M135	João Antonio	T5	g1	5	0 946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M136	José Melo	T3	g2	4	0 999	c	1	0.000				c	1	0.999				a	2	1.999										c	0	0.999
M137	Jose Barros	T7	g2	5	1 325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M138	Hylson Mota	T32	g2	7	0.841	d	1	0.392	d	2	0 588	d	1	0.785				c	3	1.177	c	2	0.785	c	3	0.981				c	0	1.177
M139	Fernando Teixeira	T4	g1	5	0 946	d	2	0.473				d	2	0.473				c	3	1.420							c	1	0.473	a	0	1.893
M140	Ednaldo Veloso	T3	g2	4	0.999	c	1	0.000				c	1	0.999				a	2	1.999										c	0	0.999
M141	José Gladis	T9	g2	5	0.568	d	1	0 000				d	1	0.473				c	2	0.946	d	2	0.473							c	0	0.946
M142	Waldimir Miranda	T2	g1	4	0 499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M143	Haylton Seara	T5	g1	5	0 946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M144	Erickson Pereira	T1	g5	4	0.999	c	1	0.999				c	1	0 999				c	2	0.999										c	0	0 999
M145	Amilcar Melo	T13	g2	5	1 136	c	2	0.473				c	2	0.946				a	3	1.893							c	1	0 473	a	0	1.893
M146	Eloy Soriano	T1	g5	4	0 999	c	1	0.999				c	1	0.999				c	2	0.999										c	0	0.999
M147	Luiz Petribu	T14	g2	6	1 337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005

Table A.3.2. Modern houses: the sectors' data

House		Sectors'			House	Social			Social 1			Service			Service 1			Private			Int. Mediator			Int. Mediator1			Ext. Mediator			Exterior		
number	owner	type	genotype	size	MRRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA
M148	Clemente Ribeiro	T1	g5	4	0.999	c	1	0.999				c	1	0.999				c	2	0.999										c	0	0.999
M149	Edmundo Machado	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M150	Geraldo Aguiar 1	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M151	Luiz Numeriano	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M152	Wilson Fontenelles	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M153	7359/1-6	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M154	Frank Svenson	T26	g2	7	0.953	d	2	0.392	a	4	1.570	d	2	0.588				c	3	0.981	d	3	0.588				c	1	0.785	a	0	1.766
M155	Enário Castro	T19	g1	6	0.955	d	1	0.573	a	3	1.432	d	1	0.573				a	3	1.432	c	2	0.286							c	0	1.432
M156	Paulo Meirelles	T12	g1	5	1.136	c	2	0.946				c	2	0.946				c	3	1.420							c	1	0.473	a	0	1.893
M157	Salviano Machado	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M158	Casimiro Pires	T22	g2	6	0.955	d	2	0.573				c	2	1.146				a	3	1.719	c	2	0.573				d	1	0.286	a	0	1.432
M159	Dilhermano Melo	T14	g2	6	1.337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
M160	Rosa Borges	T34	g1	8	1.087	c	2	0.725	a	4	1.305	c	2	0.725	a	4	1.305	a	4	1.305	c	3	0.435				c	1	1.015	a	0	1.885
M161	Geraldo Gomes/Nehilde Trajano	T6	g1	5	1.136	c	1	0.946				c	1	0.946				a	3	1.893	c	2	0.473							c	0	1.420
M162	Esdras Marques	T29	g2	7	0.897	d	1	0.392	a	3	1.373	d	2	0.588				a	3	1.373	c	2	0.392				d	1	0.981	c	0	1.177
M163	Zenaldo Rocha	T8	g1	5	0.757	d	1	0.473				d	1	0.473				c	2	0.946	c	2	0.946							c	0	0.946
M164	Joaquim Lopes	T16	g1	6	1.146	d	2	0.573				d	2	0.573				a	4	2.005	c	3	0.859				c	1	0.859	a	0	2.005
M165	Hélio S.	T24	g1	7	0.729	d	2	0.588	d	3	0.785	d	2	0.588				a	3	1.177	d	2	0.196				d	1	0.392	a	0	1.373
M166	Alfredo Correia	T3	g2	4	0.999	c	1	0.000				c	1	0.999				a	2	1.999										c	0	0.999
M167	Glauco Campello 2	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M168	Sócrates Carvalho	T16	g1	6	1.146	d	2	0.573				d	2	0.573				a	4	2.005	c	3	0.859				c	1	0.859	a	0	2.005
M169	Luiz Villar	T3	g2	4	0.999	c	1	0.000				c	1	0.999				a	2	1.999										c	0	0.999
M170	Fernando Travassos	T15	g1	6	1.241	c	2	0.859				c	2	0.859				a	4	2.005	c	3	0.859				c	1	0.859	a	0	2.005
M171	Reimar Ellrich	T4	g1	5	0.946	d	2	0.473				d	2	0.473				c	3	1.420							c	1	0.473	a	0	1.893
M172	Edne Cavalcanti	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M173	João Santos	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M174	Carlos Chermont	T27	g1	7	1.009	d	2	0.588				d	2	0.588				c	4	1.373	c	3	0.981	c	3	0.981	c	1	0.785	a	0	1.766
M175	Murilo Martins	T25	g1	7	1.121	d	2	0.588	a	4	1.570	d	2	0.588				a	4	1.570	c	3	0.588				c	1	0.981	a	0	1.962
M176	Rubens Scavuzzi	T25	g1	7	1.121	d	2	0.588	a	4	1.570	d	2	0.588				a	4	1.570	c	3	0.588				c	1	0.981	a	0	1.962
M177	José Rodrigues	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M178	Maria Tamires	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M179	Luiz Lacerda Nilo	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M180	Jose Cunha	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M181	Miguel Doherty	T3	g2	4	0.999	c	1	0.000				c	1	0.999				a	2	1.999										c	0	0.999
M182	Jose Oliveira	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M183	Clênio Torres	T19	g1	6	0.955	d	1	0.573	a	3	1.432	d	1	0.573				a	3	1.432	c	2	0.286							c	0	1.432
M184	Núbio Gadelha	T14	g2	6	1.337	c	2	0.573				c	2	1.146				a	4	2.292	b	3	1.146				c	1	0.859	c	0	2.005
M185	João Coelho	T16	g1	6	1.146	d	2	0.573				d	2	0.573				a	4	2.005	c	3	0.859				c	1	0.859	a	0	2.005
M186	Antonio J. Marinho	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M187	Emir Glassner	T19	g1	6	0.955	d	1	0.573	a	3	1.432	d	1	0.573				a	3	1.432	c	2	0.286							c	0	1.432
M188	José Jatobá	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M189	Arthur Guerra	T4	g1	5	0.946	d	2	0.473				d	2	0.473				c	3	1.420							c	1	0.473	a	0	1.893
M190	Paulo de Melo-D1	T9	g2	5	0.568	d	1	0.000				d	1	0.473				c	2	0.946	d	2	0.473							c	0	0.946
M191	João Pessoa de Souza	T25	g1	7	1.121	d	2	0.588	a	4	1.570	d	2	0.588				a	4	1.570	c	3	0.588				c	1	0.981	a	0	1.962
M192	Oswaldo Lobo	T5	g1	5	0.946	d	1	0.473				d	1	0.473				a	3	1.893	c	2	0.473							c	0	1.420
M193	Marupirajó Oliveira	T6	g1	5	1.136	c	1	0.946				c	1	0.946				a	3	1.893	c	2	0.473							c	0	1.420
M194	Paulo de Melo-D4	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M195	Paulo de Melo D6	T2	g1	4	0.499	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999
M196	Paulo de Melo-D2	T2	g1	4	0.500	d	1	0.000				d	1	0.000				c	2	0.999										c	0	0.999

Table A.3.2. Modern houses: the sectors' data

	House	Sectors'			House	Social			Social1			Service			Service1			Private			Int. Mediator			Int. Mediator1			Ext. Mediator			Exterior		
number	owner	type	genotype	size	MRRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA	st	d	RRA
M197	Francisco Pedrosa	T17	g1	6	0.859	d	1	0.573				d	1	0.573				c	3	1.146	c	2	0.859	c	2	0.859				c	0	1.146
M198	Ernesto Melo	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M199	Marcelo Silveira	T7	g2	5	1.325	c	1	0.473				c	1	1.420				a	3	2.367	b	2	0.946							c	0	1.420
M200	Carlos F. Pontual	T13	g2	5	1.136	c	2	0.473				c	2	0.946				a	3	1.893							c	1	0.473	a	0	1.893
M201	Fernando Maranhão	T3	g2	4	0.999	c	1	0.000				c	1	0.999				a	2	1.999										c	0	0.999
M202	Sônia Mesquita	T13	g2	5	1.136	c	2	0.473				c	2	0.946				a	3	1.893							c	1	0.473	a	0	1.893
M203	Jorge Wicks	T25	g1	7	1.121	d	2	0.588	a	4	1.570	d	2	0.588				a	4	1.570	c	3	0.588				c	1	0.981	a	0	1.962
M204	Gilberto Trindade	T9	g2	5	0.568	d	1	0.000				d	1	0.473				c	2	0.946	d	2	0.473							c	0	0.946